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Contents

ABSTRACTS OF PAPERS PRESENTED AT THE FALL MEETING OF THE SOCIETY OF NORTH CAROLINA BACTERIOLOGISTS AT RALEIGH, N.C., ON NOVEMBER 8, 1958 1

SOME OBSERVATIONS ON THE AUTECOLOGY OF THE CILIATE *CONCHOPHTHIRUS MYTILI* ..... *C. Dale Beers* 3

THE RIVER FROG, *RANA HECKSCHERI* WRIGHT, IN NORTH CAROLINA *Charles E. DePoe and John B. Funderburg* 11

SUMMER MARITIME BIRDS OF SOUTHEASTERN NORTH CAROLINA *John B. Funderburg, Jr. and Thomas L. Quay* 13

Continued on outside back cover

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ABSTRACTS OF PAPERS PRESENTED AT THE FALL MEETING OF THE SOCIETY OF NORTH CAROLINA BACTERIOLOGISTS AT RALEIGH, N. C., ON NOVEMBER 8, 1958

1. SOME BACTERIOLOGIC STUDIES ON WILD ANIMALS IN NORTH CAROLINA. *Nell Hirschberg, N. C. State Laboratory of Hygiene, Martin Hines, N. C. State Board of Health, and Robert Menges and Mildred Galton, C.D.C., Chamblee, Georgia.*

2. THE EFFECT OF PARTIAL STERILIZATION OF SOILS BY CHEMICALS, UPON DIFFERENTIAL MICROBIAL NUMBERS, CO_2 ACTIVITY AND RATES OF ORGANIC MATTER DECOMPOSITION. *Gerald H. Elkan and W. E. C. Moore. Department of Botany and Bacteriology, N. C. State College, Raleigh, North Carolina and Dept. of Bacteriology, Virginia Polytechnic Institute, Blacksburg, Virginia.* Varying rates of calcium hypochlorite, mercuric chloride and sodium propionate were used as partial sterilization agents in field and greenhouse trials, for the purpose of altering soil biological activity and thereby decreasing organic matter decomposition rates. Application of all levels of sodium propionate resulted in immediate increased respiration rates. This phenomenon was observed in greenhouse, field, and tumbler trials. Fungi counts decreased and bacterial numbers increased greatly when this chemical was used. Mercuric chloride and calcium hypochlorite at lower levels also stimulated CO_2 activity immediately after treatment. Within 4 weeks after treatment, all rates of the various chemicals depressed soil CO_2 evolution. One year after treatment, plots treated with 100 pounds of mercuric chloride per acre had ¼ as many actinomycetes and total microbes and ⅛ as many fungi. Respiration was also considerably lower. Calcium hypochlorite treated plots retained reduced total counts and sodium propionate reduced fungi counts. Respiration in these last plots was not depressed. Chemical treatment was effective in altering the microbial ecology at least for thirteen months.

On a newly established pasture, statistically significant decreases in organic matter decomposition rates were attributable to chemical treatment. Trends in the other trials indicated that sodium propionate might be of some value in altering decomposition rates but the data are somewhat anomalous.

General lack of correlation between the three measures of biological activity used in this study, indicates the necessity for further development of methods for determining estimates of the population of microorganisms in soils.

3. INHIBITION OF DIAMINOPIMELIC ACID DECARBOXYLASE ACTIVITY IN MYCOBACTERIUM TUBERCULOSIS BY ISONICOTINIC ACID HYDRAZIDE. *Hilda Pope Willett, Duke University School of Medicine.*

4. CROSS REACTIONS TO TUBERCULIN IN GUINEA PIGS. *William Johnston, Duke University School of Medicine.*

5. ENUMERATION OF MENINGOPNEUMONITIS VIRUS PARTICLES BY PHASE CONTRAST MICROSCOPY. *K. O. Smith and G. P. Manire, Department of Bacteriology and Immunology, University of North Carolina School of Medicine, Chapel Hill.* A simple, rapid technique for determining the number of virus particles contained in a suspension has been developed. Polystyrene particles 0.81 μ in diameter are diluted in distilled water and the number of particles per ml determined by counting in a bacterial counting chamber. An equal volume of virus suspension is added to the standard polystyrene suspension, mixed, the mixture smeared on a glass slide, heat fixed and stained with basic fuchsin. The ratio of the two particle types is determined by counting with phase contrast illumination. The number of virus particles present in the unknown suspension is thereby calculated. The precision of the method has been demonstrated in repeated counts on the same virus suspension. The validity of this technique is supported by demonstrating constant relationships between virus counts by this method and

egg infectivity titrations, total nitrogen determinations, and electron microscope counts. The use of polystyrene particles as a standard has several advantages. This material is stable on storage, is readily available, easily standardized, easily visualized by phase contrast microscopy, and is readily differentiated from the virus particles.

6. ADAPTATION OF MENINGOPNEUMONITIS VIRUS TO GROWTH IN HELA CELL CULTURES. *G. O. Galasso and G. P. Manire, Department of Bacteriology and Immunology, University of North Carolina School of Medicine, Chapel Hill.* Meningopneumonitis virus, a member of the psittacosis-lymphogranuloma venereum group, has been grown and studied in a variety of cell culture systems, but growth in HeLa cells has not been reported. In a preliminary experiment in 1953 in which HeLa cells were inoculated with this agent, rapid and extensive virus proliferation was observed, but no further growth was obtained in subcultures. Further studies have been conducted recently to determine whether adaptation of this agent can be achieved by passage or long term culture.

Preliminary attempts to obtain growth in HeLa cells in maintenance solution (Scherer) failed. In further experiments, infected cells were fed regularly with Eagles medium without subculturing. After an adaptive period, virus in increasing amounts was observed, but without macroscopic evidence of cell lysis or plaque formation. Two bottles which were maintained in this manner have been producing virus for over 6 months. Over 40 harvests of 5 ml each have been made from each bottle, each harvest averaging 10^8 virus particles per ml. This persistent type of infection has been reported for several viruses but has not been observed with members of this group.

Comparisons of toxicity and egg infectivity characteristics of HeLa grown virus and virus from allantoic cavity have shown no significant differences.

SOME OBSERVATIONS ON THE AUTECOLOGY OF THE CILIATE *CONCHOPHTHIRUS MYTILI*[1]

By C. Dale Beers

Department of Zoology, University of North Carolina, Chapel Hill, North Carolina, and the Mount Desert Island Biological Laboratory, Salisbury Cove, Maine

Conchophthirus mytili is a common ectocommensal of the foot and adjacent surfaces of the marine mussel *Mytilus edulis*. It creeps actively over the surface of the foot, to which it adheres loosely by the thigmotactic cilia of its left (physiologically ventral) side. Its distribution appears to be coextensive with that of its host, and in the opinion of Raabe (1949) it is strictly specific for *Mytilus edulis*. Although there is little doubt that it is properly assigned to the Suborder Thigmotrichina of the Order Holotrichida, its correct generic name has been a subject of disagreement. For example, Raabe in 1934 established the genus *Kidderia* to receive it, and Kahl in the same year assigned it to his new genus *Morgania*. However, an examination of "Nomenclator Zoologicus" (Neave, 1939–50) reveals that *Kidderia* Raabe, 1934, is a homonym of *Kidderia* Dall, 1876, a mollusk; and that *Morgania* Kahl, 1934, is a homonym first of *Morgania* Smith, 1854, a hymenopteran, and secondly of *Morgania* Cossmann, 1906, a mollusk. Hence, both *Kidderia* Raabe and *Morgania* Kahl are invalid. Since it is not decisively clear that the various species commonly assigned to *Conchophthirus* differ sufficiently among themselves to justify the subdivision of the genus, I shall follow the more conservative procedure of Kudo (1954) and employ the generic name *Conchophthirus* Stein, 1867. Thus the ciliate remains for the present *Conchophthirus mytili* De Morgan, 1925.

The morphology, division, and conjugation of *C. mytili* were described quite thoroughly by Kidder (1933, 1933a), who used mussels from the environs of New York City and from Woods Hole, Massachusetts. On the other hand, the relation of the ciliate to its host and to its marine environment—that is, its autecology—has received little more than casual mention in the literature. The present study, which is based on mussels collected in July and August, 1958, on the shore near the Mount Desert Island Biological Laboratory, concerns certain admittedly limited aspects of its autecology, in particular, its occurrence and division in relation to the cycles of water propulsion of the host and its ability to live in sea water when removed from the host. Other aspects, such as the nature of its food and its cultivability, receive incidental mention. These mussels also had in the mantle cavity a second ciliate, the small thigmotrich *Ancistruma mytili*, but it is not the subject of the present study. Whenever the terms "*Conchophthirus*" and "ciliate" are used without qualification in the following pages, *Conchophthirus mytili* is meant.

[1] This investigation was supported in part by a grant from the University of North Carolina Research Fund.

Materials and Methods

In the studies conducted by Kidder in New York City the mussels were transported in thermos jugs from the sites of collection to the laboratory and were kept in aquaria of aerated sea water. In the Woods Hole studies they were kept in aquaria of running sea water. The mussels from both sources lived for months in the laboratory, and the ciliates of the Woods Hole mussels survived for weeks; but the ciliates in the New York aquaria fared poorly and disappeared within a few days, indicating that they are distinctly more sensitive to environmental changes or inadequacies than are their hosts.

In view of the somewhat unfavorable response of *Conchophthirus* to aquarium conditions, it was deemed inadvisable in the present study to keep any mussels in aquaria, but to collect them as needed and to use them at once. Thus, whenever ciliates were desired, six to ten mussels were collected in a small basket, always between the tide lines on the gently sloping rocky expanse adjoining the Laboratory. Their transportation into the Laboratory required only a few minutes, and in general all the mussels of each such collection were opened and utilized within an hour or two after their removal from the shore. Mussels of all sizes from relatively small unattached

specimens to those having a valve length of 75 mm. were available in nearly uncountable numbers, and individuals of many differing shell-lengths were taken from various sites within a distance of 100 meters of the Laboratory. Some of the mussels were collected at low tide when they were out of the water and thus were not feeding; others were taken at high tide when they were submerged in 2 to 3 m. of water and were presumably feeding. In the following section these mussels are regarded as constituting two categories: low water and high water specimens. Mussels that occurred below the level of low tide and thus were never out of water are excluded from consideration, since time was not available for a study of their ciliate fauna.

The mussels were opened in the general manner described by Kidder (1933), that is, by cutting through the posterior adductor muscle, but it is necessary to include here some further details concerning the procedure. A scalpel was inserted between the ventral margins of the valves just posterior to the byssus, the adductor was transected, and the valves were pressed slightly apart. The fluid of the mantle chamber, consisting now of sea water plus an admixture of blood from the damaged tissues, was allowed to drain through the posterior gape of the valves into a Syracuse watch glass. Although this fluid was regularly examined for ciliates, it contained relatively few—usually not more than two or three specimens—since *Conchophthirus* is primarily a surface-adherent ciliate rather than a freely swimming form. The mantle fluid was discarded, and about 10 ml. of sea water was spurted over the foot and adjacent surfaces, thus washing the ciliates into a second watch glass, where they were available for immediate observation or for further use. Although *Conchophthirus* adheres tenaciously to glass surfaces, from which it is very difficult to dislodge, it adheres loosely to the ciliated foot and foot retractors, from which it is therefore readily dislodged by a stream of water from a pipette.

Number of Ciliates per Mussel and Their Division in Relation to Water Propulsion

Rao (1954) made the remarkable observation that the rate of water propulsion through the mantle cavity of *Mytilus* "corresponds in time and degree to the tidal levels in the locality" from which the specimens were taken. Since the stream that enters the mantle chamber brings in food, not only of *Mytilus* but of *Conchophthirus*, the question arises whether any of the physiological or morphogenetic activities of the ciliate are correlated with the cycles of water propulsion and food intake; that is, does the ciliate feed and grow principally when its host is actively engaged in water propulsion and feeding, and then divide when the host is out of water and thus not actively feeding? Or is there no correlation between the growth and division of the ciliate and the cycles of water propulsion? This general question was studied, using as the criterion of ciliate activity the percentage of ciliates found in division in mussels of the two categories that have been mentioned. On the whole, divisional forms of *Conchophthirus* are easily identified—advanced stages of division by the presence of two macronuclei or by the usual transverse cytosomal constriction, early stages by the elongation of the conspicuous macronucleus in the longitudinal axis of the ciliate. It is recognized that this procedure is not entirely infallible, in that the daughter products of a very recent division cannot be distinguished with certainty from small trophic specimens, nor is it possible to identify the very early divisional stages in which only the micronuclei have divided. Nevertheless, division as a criterion of metabolic activity in ciliated protozoa is one of the best, bearing in mind that measurable features in the Ciliata are difficult to come by.

The results are summarized in Table I. With reference to the larger mytili (valve length, 40–75 mm.), they show that mussels collected at low water contained on the average about the same number of ciliates per mussel as those collected at high water, namely, about 32 (Column 5), and that the percentage of ciliates in division was approximately the same in both categories (about 5 per cent, Column 7). Smaller attached mussels (valve length, 13–39 mm.) contained on the average distinctly fewer ciliates per mussel (about 9 to 10), whether collected at low water or high water, but again the percentage of ciliates in division was essentially the same in both categories (about 4.5 per cent, Column 7). Thus it is evident that the division of *Conchophthirus* in the Mount Desert Island region is not correlated with the cycles of water propulsion of the host. Although the results were of a negative kind, they are not without significance. They show actually that in *C. mytili* food ingestion, growth, and division are continuous rather than rhythmic processes and

TABLE I

Relation of the Number of Individuals and the Division of the Ciliate Conchophthirus mytili *to the Size of Its Host,* Mytilus edulis, *and to Some Tidal Conditions in July and August, 1958, at Salisbury Cove, Maine*

Number and Condition of Mussels Examined	Range of Valve Length in mm.	Approximate Level of Tide at Time of Collection	Total No. Ciliates in Mussels	Av. No. Ciliates per Mussel	Total No. Ciliates in Division	Percentage Ciliates in Division
Attached						
100	40–75	Low	3104	31.0	168	5.4
70	40–75	High	2358	33.7	114	4.8
50	13–39	Low	454	9.1	19	4.2
50	13–39	High	512	10.2	24	4.7
Unattached						
25	6–11	Low	0			
25	6–11	High	0			

thus are independent of water propulsion and tidal levels.

Some preliminary attempts were made to use the number of food vacuoles per ciliate as a measure of activity, but these attempts were abandoned, since all the ciliates from the mussels of both categories contained scores of food vacuoles, which varied in diameter from 5 μ to 18 μ. Kidder (1933, p. 10) remarks that "food vacuoles are usually very numerous" and that "they crowd the endoplasm throughout the body." Counts of the number of food vacuoles showed little more than the fact that the number of vacuoles is directly proportional to the size of the ciliate.

A further comment on the results of Table I is needed concerning the small unattached mussels, the adhesive foot of which was functioning actively as an organ of locomotion at the time of observation. These mussels were never found to contain ciliates, probably because the constant muscular activity of the foot is detrimental to the establishment of a ciliate fauna on its surface.

Finally, a word concerning conjugation should be appended at this point. Although conjugation is well known in *Conchophthirus* (Kidder, 1933a), only four pairs of conjugants were noted among more than 6000 ciliates that were examined in July and August, 1958. Since the factors that induce conjugation in *Conchophthirus* are not understood, all that can be said is that the physiological condition of the ciliates was unfavorable for conjugation.

SURVIVAL IN SEA WATER WHEN REMOVED FROM THE HOST

Since 4 to 5 per cent of the ciliates were regularly found to be dividing, a ciliate population of considerable size might reasonably be expected in each mytilus. Actually, this expectation was not realized; the number per mussel was quite unpredictable and was never great. The largest number that I found was 83 in a mussel that had a valve length of 75 mm., though one mussel of this same size had none. Kidder (1933) reports 5 to 10 as the average in his mussels, and 50 to 75 per mussel as a "good find." The latter figures apply equally well to the larger mussels of the present study, though the average per mussel was higher (Table I, Column 5). A relatively small number of ciliates per mussel combined with a rather high rate of division (about one ciliate in division in every 20) indicates that ciliate losses from the host are considerable. As possible sources of loss, the following come to mind: death from unknown causes; accidental ingestion by the host; and expulsion in the excurrent water in consequence of movements of the foot, mantle, or valves. Of these possibilities, loss by expulsion in the excurrent stream seems the most probable one. Such loss implies that *C. mytili* has considerable tolerance for sea water, since it must be able to survive in this medium until it arrives in another host. In regions where tidal extremes are great (3 to 3.7 m. at Salisbury Cove) and enormous volumes of sea water pass four times daily over the mussel beds, the ability of the ciliate to live for some hours away from its host seems imperative. On the contrary, Kidder found that his specimens could live no longer than an hour or two in sea water away from the foot of the host. Therefore, the ability of *C. mytili* to live in sea water after removal from its host was re-examined in the present study.

If a few specimens of *Conchophthirus* are transferred by means of a small pipette to a watch glass containing pure sea water, they swim downward and creep in circles on the bottom of the watch glass. Occasionally one of them leaves the bottom, swims upward, and creeps in circles beneath the surface film for some moments, after which it returns to the bottom. Such specimens show no reversal of the direction of locomotion, neither do they show any avoiding reactions or aberrancies in their manner of swimming; that is to say, their behavior indicates that pure sea water is entirely favorable for their survival. However, the transfer of any appreciable number of individuals from

one dish to another by means of a pipette is not at all feasible. Not only are they extremely difficult to dislodge from the bottom of the first dish, but once dislodged they adhere firmly to the inner wall of the pipette, from which they can only be dislodged with even more difficulty, and some of them are usually distorted or injured in the process. Thus a procedure was followed that utilized the adhesive properties of the ciliates as a means of retaining them in a watch glass, while the fluid was poured off. In this procedure the 50 to 75 ciliates of a relatively heavily infected mussel, which could be chosen only by trial and error, were washed in the manner described earlier from the foot into a watch glass, to the bottom of which they adhered tightly. The fluid (sea water plus a small amount of blood) was decanted, leaving the ciliates in a thin layer of fluid on the bottom. Then a stream of fresh sea water from a pipette was directed onto the bottom and inner wall of the watch glass, in order to detach any adherent lymphocytes and to disperse in the sea water the film of diluted blood plasma that tended to adhere to the glass surface. To be sure, some of the ciliates were also detached, but they settled quickly to the bottom, and the fluid was again decanted. This procedure was then repeated four times, making six decantings in all, so that the ciliates finally arrived in 10 ml. of practically pure sea water in the watch glass. It is true that about 25 per cent of the ciliates were lost in the process, but as a rule 40 to 60 of them still remained. Each such watch glass was then removed to a covered Stender dish of transparent glass to protect it from dust and to reduce evaporation. Some of the Stender dishes were painted black externally, so that the contained ciliates were in darkness, as in the mantle cavity in nature. Other Stender dishes were left unpainted, and the ciliates in these received the diffused natural light of the laboratory by day, but were in darkness by night. As a convenient means of maintaining the ciliates at the summer temperature of Salisbury Cove sea water (14° C.), the Stender dishes were kept in a shallow tray of fresh running sea water (depth of water in the tray, about 3 cm.; height of Stender dishes, 4 cm.).

Although the histories of these respective watch-glass preparations can readily be reduced to tabular form, the procedure is scarcely justified in view of the uniformity and conclusiveness of the results. Therefore, the presentation will be restricted to the histories of two representative preparations, as described in the following two paragraphs, all the times cited being counted from the beginning of the experiment.

July 29. 67 ciliates, size 150–190 μ x 100–120 μ, food vacuoles numerous in each, transferred to sea water at 9:00 A. M., exposed to the natural periods of light and darkness of the laboratory; temperature, 14° C. Their condition after 10 hours: all alive, normal in structure and behavior, creeping on the bottom and evidently attempting to feed. After 24 hours and again after 34 hours: no significant change from the foregoing. After 48 hours: all alive and structurally normal, but smaller in size, thus measuring 130–150 μ x 70–80 μ; the cytoplasm nearly depleted of food vacuoles; most of them creeping just beneath the surface film, though the significance of this reaction is unexplained. After 72 hours: only 42 present; smaller than foregoing, enfeebled, quite depleted of food vacuoles; most of the survivors apparently normal in structure and behavior, though some abnormal, the latter distended by large fluid vacuoles and swimming erratically. After 84 hours: all have perished.

July 29. 57 ciliates, like the foregoing in size and number of food vacuoles, removed to sea water at 9:30 A. M., kept in darkness except during brief intervals of observation; temperature, 14° C. Condition after 10, 24, 34, and 48 hours, respectively, quite like that of the specimens described in the preceding paragraph. After 72 hours: only 38 present, but similar to those of the preceding paragraph. After 84 hours: none.

Repetitions of the foregoing experiment yielded confirmatory results. A comparative examination of all the results leads to the following conclusions. Pure sea water is in no wise toxic or injurious to specimens of *C. mytili* that have been removed from the foot of the host, provided they are kept at the temperature to which they are accustomed in nature. They tolerate sea water well for 48 hours, and some can survive in it for 72 hours without showing observable changes in structure or behavior. A period of 84 hours in sea water is fatal, but their death under these conditions results from starvation, rather than from any unfavorable properties of the water. (That their death actually resulted from starvation is shown by the gradual disappearance of food vacuoles from the cytoplasm and by the absence of division. The few cases of division that occurred were in individuals that were already beginning to divide when they were transferred to sea water.) They survive in sea water equally well whether in continuous darkness or in the alternate

periods of light and darkness of the laboratory; that is, there is no evidence from these experiments (or from any observations that were made) that light of moderate intensity is injurious; in fact, *C. mytili*, like other ciliated protozoa, seems to be indifferent to light. Finally, *C. mytili* is well adapted to survive in sea water away from its host for a period of time (at least 48 hours), which is sufficient to insure with reasonable certainty its dissemination throughout a *Mytilus* population.

SURVIVAL IN SEA WATER AT SOME TEMPERATURES ABOVE NORMAL

In July and August at Salisbury Cove the temperature of the sea water in which *Mytilus*, plus its contained ciliates, passes the major part of each 24-hour period is about 14° C., as has been indicated. (The reference, as mentioned earlier, is restricted to those mytili that live between the tide lines.) Since the nights are cool, its stay out of water at the time of the nocturnal low tide does not appreciably affect its body temperature. The mussel experiences a higher temperature only when the diurnal low tide occurs in the middle of a sunny day, meaning between 10:00 A. M. and 4:00 P. M., but the temperature within the mantle chamber, even on a hot day (air temperature, 32° C.), is well below the air temperature, since practically all the mussels are either in contact with, or actually imbedded in, the cooler substrate of rock and mud. Nevertheless, preliminary observations indicated that the temperature inside the mantle cavity of an exposed mussel may reach 22° C. on a sunny day. This implies that *Conchophthirus* in nature at Salisbury Cove must be able to tolerate for several hours each day a temperature which is well above that of sea water.

Its tolerance for some temperatures higher than 14° C. was therefore examined experimentally. Since the ability of *Conchophthirus* to live for 48–72 hours in watch-glass preparations of sea water at 14° C. has been demonstrated, and since such preparations afford a simple means of observing the ciliate, the experiments were extended to test the effect of two higher temperatures, namely, 22° C. and 30° C. The results may be summarized briefly as follows. After 24 hours in sea water at 22° C., all the ciliates were alive and normal with respect to structure and behavior; after 30 hours about 25 per cent of them had perished and some of the remaining ones were swimming erratically; at the end of 48 hours, all had disappeared. In the watch-glass preparations that were kept at 30° C., all the ciliates were dead at the end of 10 hours.

From these experiments it is seen that *Conchophthirus* in summer at Salisbury Cove has considerable tolerance for a temperature (22° C.) that is well above the normal temperature of sea water. This tolerance has definite survival value, in view of the warming effect of the sun when mussels are exposed at low water on sunny summer days. However, a temperature of 30° C. is soon fatal. In general, when *Conchophthirus* becomes the subject of laboratory study the temperature that it normally encounters in nature should not be exceeded. It is possible that the failure of Kidder's specimens to survive in sea water in the laboratory resulted from an unfavorable increase in temperature, though it is also possible that they were in a semi-starved condition when removed from the host.

BEHAVIOR ON SOME CILIATED AND NON-CILIATED SUBSTRATA

The possibility of ciliate loss by accidental ingestion on the part of the host has been mentioned. Although the esophagus of *Mytilus* is relatively small, this possibility may not be arbitrarily excluded, in that many types of particulate matter, both living and non-living, may become entangled in the mucus of the gills and be carried to the mouth. The relation of *Conchophthirus* to various surfaces of the foot region and to the gills was therefore examined.

To observe *Conchophthirus* in its natural habitat, the adductor is transected, the valves are pressed apart, and the mussel is laid gape uppermost in a finger bowl of sea water and examined under strong incident light with the dissecting binocular. The ciliates are then seen with no difficulty as white bean-shaped objects that creep constantly and unhurriedly on the ciliated surface of the foot. A few of them also occur on the ventral lip of the inner palps, still fewer near the foot on the surfaces of its retractor muscles. They are not found on the byssal threads or on the gills, nor were they observed to leave the foot and adjacent surfaces and swim freely in the water. However, the foot is capable of considerable elongation and contraction, and some of them undoubtedly become detached from time to time under natural conditions and are expelled in the exhalent stream.

What is the behavior of *Conchophthirus* if it is removed to the strongly ciliated surface of the gills, which are the principal organs of food cap-

ture in pelecypods? In order to examine this point, a gill lamina was excised along its dorsal margin and laid in a finger bowl of sea water. Excision does not affect the smoothly coordinated movements of the cilia of the gill filaments; thus the food-collecting activities of the gill continue, though with the secretion of an amount of mucus that is somewhat greater than normal, according to White (1937). Several specimens of *Conchophthirus* were then transferred from the foot of an opened mussel to the surface of the excised gill lamina.

Specimens thus transferred creep actively, often in clockwise circles (as viewed from above), on the surface of the gill, their locomotion being unaffected by the ventrally directed strokes of the strong frontal cilia of the filaments. Occasionally one of them creeps from the ventral margin of the gill dorsally on a gill filament, thus traversing the entire ventro-dorsal extent of the gill against the direction of the effective strokes of the frontal cilia. Indeed, their ability to glide with such apparent ease over a coarsely ciliated surface is remarkable.

In the meantime a thin layer of mucus is carried ventrally on each surface of the lamina and the two layers meet at its ventral margin. Here they unite to form a mucous strand that moves anteriorly in the food groove of the lamina, as in normal feeding. More or less incorporated into the substance of the strand are lymphocytes, particles of detritus, diatoms, and the like.

From time to time a ciliate in the course of its excursions over the gill surface arrives at the ventral margin, where it comes in contact with the mucous strand of the food groove. On the mucous strand it creeps seemingly with hesitation, either anteriorly in the direction of the moving strand or in the opposite direction. Then its response is unvarying: it leaves the mucous strand and swims away from the gill into the surrounding water. If we assume that this is its normal response to a mucous substratum, there is no likelihood of its ingestion by the host.

Its failure to leave the gill as long as it is on a ciliated surface and its invariable departure when it arrives on a (non-ciliated) mucous surface reveal perhaps something significant concerning the physical nature of the substratum that *Conchophthirus* requires. Its behavior suggests that it is adapted for life on a ciliated substratum and that a non-ciliated surface is unsuitable. It is true that certain objections to this suggestion present themselves at once, among them the following two: (1) the inner surface of the mantle is ciliated, as is the gill surface, yet *Conchophthirus* does not occur normally on either surface; (2) in a watch glass of sea water *Conchophthirus* adheres tenaciously to the glass and creeps successfully against the surface film, neither of which is ciliated. With reference to the first objection, it may reasonably be assumed that *Conchophthirus* possesses certain chemotactic properties that also affect its selection of a substratum, though little is known concerning these properties. Thus ciliation, we may assume, is not the only requisite of the substratum. With reference to the second objection, it is self-evident that a watch glass is not its normal habitat and that it has no alternative in a watch glass but to adhere to that surface which is available. Thus its adhesion to a glass surface is only an expression of the dominance of thigmotaxis in its behavioral responses, and ciliation remains, at least in my opinion, an essential attribute of its normal substratum. It is planned that this question shall receive further study.

Observations on Food and Cultivability

In spite of the abundance of food vacuoles in freshly collected specimens of *Conchophthirus*, the various items that constitute its food have not been adequately identified. Many of the vacuoles contain relatively little particulate matter, indicating that considerable fluid is ingested during feeding. Some of them contain bacteria, some contain seemingly nondescript material, and others contain irregularly-shaped masses that have the same brownish color as the pigment of the ciliated epithelium of the foot. Some of the ciliates were treated with Lugol's solution in an effort to identify any starch of phytoplanktonic origin, but the results were inconclusive in that they indicated the presence of glycogen. Diatoms were never found in the food vacuoles, nor were dinoflagellates. Attempts to feed the ciliates on fine detritus in watch-glass preparations of sea water were unsuccessful. Kidder's statement (1933, p. 10) that the food vacuoles "are filled mainly with algae and plankton," though in many cases with sperm cells of the host, is no doubt correct in a general way, but it is not sufficiently specific to be really informative. However, the nature of the food was not the subject of Kidder's investigation.

In the present study some incidental observations were made on the food and the culture of *Conchophthirus*. Although the subject was not

pursued at length, some of them are none the less of interest. A watch glass, which through inadvertence was not washed at the end of the day, was found 24 hours later to contain some 3 dozen well-fed ciliates, many of which were dividing. A careful examination of the fluid of the watch glass, which consisted of sea water plus a small amount of *Mytilus* blood, revealed a considerable number of lymphocytes, many rod-shaped non-motile bacteria, and some small colorless flagellates. Since the sea water of the Laboratory was quite inadequate for the growth and division of *Conchophthirus*, as has been pointed out, it was evident that the *Mytilus* blood was in some unexplained way responsible for the growth and division of the ciliates.

Therefore, the capability of a mixture of sea water and *Mytilus* blood to sustain growth and division in *Conchophthirus* was examined, as follows. Five drops (about 0.25 ml.) of *Mytilus* blood were added to the 10 ml. of sea water of a standard watch-glass preparation that contained 30 specimens of *Conchophthirus*, and the watch glass was transferred to a sea-water tray in which it received the usual laboratory illumination. Five drops of blood were likewise added to a second watch glass of sea water, which contained 50 ciliates, but this watch glass was kept in darkness. The watch glasses had similar histories, as follows.

At the end of 18 hours the first watch glass contained 63 normal, active ciliates, representing approximately a two-fold increase. Some of them were large (about 180 μ x 135 μ) and contained many food vacuoles; others were small (about 135 μ x 95 μ) and contained relatively few vacuoles. Twenty-four hours later 92 ciliates were present, showing that many members of the population—probably the larger ones—had undergone a second division, but all the ciliates now contained rather few food vacuoles and were obviously in a weakened condition. An attempt to subculture some of them failed, and all the specimens of the experiment perished in the succeeding 24-hour period.

At the end of 18 hours the second watch glass contained 108 ciliates, again slightly more than a two-fold increase; 24 hours later it contained 144, but most of them were definitely enfeebled; 24 hours later only six small moribund specimens remained.

A repetition of the foregoing cultural attempts yielded similar results. Although the ciliates of these four watch glasses divided only once or twice, the first division was clearly preceded by food ingestion and growth, since many of the daughters were as large as the original parents; that is, the increase in numbers was not an example of division in the absence of food ingestion and growth, as occurs in some ciliated protozoa, notably *Didinium nasutum* (Mast, 1909). Thus the experiments constitute, in so far as I am aware, the first attempt in the culture of *Conchophthirus mytili* that has resulted in even a modicum of success; they indicate that the preparation of a culture medium for *Conchophthirus* is quite within the limits of feasibility and that light is a matter of little or no consequence.

What was the role of the *Mytilus* blood in these cultural attempts? At first sight the results supported the conclusion that *Conchophthirus* can feed on lymphocytes, which have an average diameter of about 10 μ (Field, 1922) and which might possibly serve as food. That this conclusion was premature was readily demonstrated as follows. Some *Mytilus* blood was centrifuged with enough force to sediment the lymphocytes, and only the plasma was added (as formerly in 5-drop amounts) to each watch-glass preparation. Four such watch-glass cultures, each containing 30 to 50 ciliates, were prepared and maintained as usual at 14° C., two in darkness and two under laboratory illumination. In one of the watch glasses the ciliates failed to divide, but in the remaining three, which included the two kept in darkness, they fed, grew, and divided once, and some of them divided a second time before the cultures declined. Thus these three cultures repeated the history of the preceding four, and the results indicated, therefore, that lymphocytes are not necessary for the growth and division of *Conchophthirus*. What then constituted the food of the ciliates in the successful watch-glass cultures? A careful examination of the fluid of the watch glasses showed that it contained at least two kinds of organisms that might serve as food: non-motile rod-shaped bacteria and small, spherical, colorless flagellates, which measured about 6μ in diameter. Staining of the flagellates with Schneider's acetic carmine revealed in each a nucleus about 2μ in diameter. Then an examination of some of the ciliates from the watch glasses, including staining in acetic carmine, was made. The food vacuoles contained rod-shaped structures, believed to be bacteria, and small nucleated spheres, thought to be colorless flagellates. However, some of them appeared to contain delicate, coiled, filamentous structures, and others contained brownish masses of quite unidentified material.

Actually, the food of *Conchophthirus* is probably somewhat varied, and considerable additional study is needed to identify it with certainty. The present study indicates that two of the food organisms are rod-shaped bacteria and colorless flagellates. It is likely that the blood not only supplied food for the bacteria and flagellates, thereby increasing their numbers, but also rendered the medium more favorable chemically and physically for *Conchophthirus*.

SUMMARY

The number of specimens of *Conchophthirus mytili* per mussel and the occurrence of division were studied in relation to the cycles of water propulsion and feeding of the host, *Mytilus edulis*. In general, each mussel had from 10 to 30 ciliates and about 5 per cent of them were regularly in division, whether the mussels were collected and examined at low tide (mussels out of water) or high tide (mussels submerged). Thus no correlation was found between any activities of the ciliate and the cycles of water propulsion.

The relatively high percentage of dividing ciliates in a small total number per mussel indicates that ciliate losses, probably in the excurrent stream, are numerous, and that *C. mytili*, contrary to evidence from the literature, has considerable tolerance for sea water when removed from its host. A study of its ability to live in sea water away from its host showed that it can survive for 48–72 hours, provided the normal temperature of the water (14° C. with reference to the ciliates under consideration) is not greatly exceeded. Thus it is well adapted to live in sea water for a period of time that seems adequate to insure its maintenance and dissemination in a *Mytilus* population.

It is suggested that ciliation is an important physical property of the substratum on which *C. mytili* normally lives, though chemotaxis no doubt affects significantly its choice of a substratum.

Conchophthirus mytili can feed, grow, and divide once or twice in sea water to which a small amount of *Mytilus* blood is added, but the contribution supplied by the blood is unidentified. Its food in these preliminary cultural attempts was principally bacteria and colorless flagellates, which are probably two of the items of its normal diet.

LITERATURE CITED

DE MORGAN, W. 1925. Some marine ciliates living in the laboratory tanks at Plymouth, with a description of a new species, *Holophrya coronata*. Jour. Mar. Biol. Assoc. U. K. **13:** 600–658.

FIELD, I. A. 1922. Biology and economic value of the sea mussel *Mytilus edulis*. Bull. U. S. Bur. Fish. **38:** 127–259.

KAHL, A. 1934. Ciliata entocommensalia et parasitica. Tierwelt d. Nord- u. Ostsee. Lief. 26, Teil II. C4, 147–183. Akademische Verlagsgesellschaft: Leipzig.

KIDDER, G. W. 1933. Studies on *Conchophthirius mytili* De Morgan. I. Morphology and division. Arch. f. Protistenk. **79:** 1–24.

———. 1933a. Studies on *Conchophthirius mytili* De Morgan. II. Conjugation and nuclear reorganization. *Ibid.* **79:** 25–49.

KUDO, R. R. 1954. Protozoology, 4th ed. Chas. C Thomas: Springfield.

MAST, S. O. 1909. The reactions of *Didinium nasutum* (Stein) with special reference to the feeding habits and the function of trichocysts. Biol. Bull. **16:** 91–118.

RAABE, Z. 1934. Über einige an den Kiemen von *Mytilus edulis* L. und *Macoma balthica* (L.) parasitierende Ciliaten-Arten. Annal. Musei Zool. Polon. **10:** 289–303.

———. 1949. Remarks on protozoan parasitocenose of some representatives of genus *Mytilus*. Annal. Univ. Mariae Curie-Sklodowska **4:** 1–16.

RAO, K. P. 1954. Tidal rhythmicity of rate of water propulsion in *Mytilus*, and its modifiability by transplantation. Biol. Bull. **106:** 353–359.

WHITE, K. M. 1937. L. M. B. C. Memoirs. No. 31. Mytilus. University Press of Liverpool.

THE RIVER FROG, *RANA HECKSCHERI* WRIGHT, IN NORTH CAROLINA

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In Wright's original description of *Rana heckscheri* (1924), the range of the species is given as "Coastal Georgia and Florida." Later, the range was extended northward to the Edisto River in South Carolina by E. B. Chamberlain (1939). Recent authors (Schmidt, 1953; and Conant, 1958) have retained the latter location as the northern limit of the species.

The possibility that *R. heckscheri* could be found still further northward was first suggested by C. S. Brimley (1943) when he reported, "Recorded with some doubt from Brunswick County, N. C.", on the basis of a frog picked up dead in a heron rookery near Southport on March 14, 1938. This specimen was described by Brimley as ". . . probably . . ." *Rana heckscheri* on the basis of the color of its underparts. The present authors also do not accept this record as being positive since the characteristic of ventral coloration does not appear to be sufficient evidence, in itself, for identifying *R. heckscheri* inasmuch as specimens of *Rana catesbeiana* Shaw from Coastal Plain areas often appear heavily spotted beneath (Wright and Wright, 1949; Neill, 1958). Brimley's specimen could quite possibly, therefore, have been the latter species. This specimen is no longer extant.

On May 10, 1948, the junior author collected a frog in Greenfield Lake, New Hanover County, N. C., which fitted Wright and Wright's (1949) description of *Rana heckscheri* except that the specimen slightly exceeded their size limit of five inches in length. Because of this, no account was published of the find. Although this specimen was deposited in the North Carolina State Museum and, unfortunately, cannot now be located, it seems at this time—in light of an increase in the possible length limit to six inches by Conant (1958) and the additional records discussed herein—that the New Hanover specimen should be accepted as *Rana heckscheri* even though it cannot be re-examined.

The first definite North Carolina specimen of *Rana heckscheri* was brought to our attention by Dr. W. L. Engels (1958). The specimen was taken, as an "enormous" tadpole, by a University of North Carolina student in March, 1957, from the Black River in Sampson County. It was kept in an aquarium at the University of North Carolina where it metamorphosed in several weeks. The young frog is now in the U.N.C. study collection.

On August 7, 1958, the senior author collected a single specimen of *Rana heckscheri* at Rhodes Pond, Cumberland County, N. C. Tentative identification was made by the authors and, for positive identification, the specimen was sent to Wilfred T. Neill, of the Ross Allen Reptile Institute, who verified the identification as *Rana heckscheri* (Neill, 1958).

Two of the characteristics of *R. heckscheri* described by Wright and Wright (1949) caused the authors some concern in separating this species from *R. catesbeiana*. The Wrights mention that the venter of *R. heckscheri* is heavily mottled with black, but although this appears to be so, it has been of little value since, as previously mentioned, specimens of *R. catesbeiana* are also often heavily mottled beneath. In addition, the Wrights state (p. 468) with regard to *Rana heckscheri* "The webbing of the foot does not extend to the tip of the fourth toe, leaving about 1½ joints free." However, on the following page they remark "Like *Rana grylio* and *Rana catesbeiana* . . . no phalanx of the fourth toe is totally free of web. . . ".

A characteristic of *R. heckscheri* which is not emphasized by the Wrights is the mottling of the upper jaw. Neill (1958) states, "This species is readily distinguished by the presence of dark and light spotting on both the upper and lower lip. In *Rana catesbeiana*, the upper lip is unicolor, the lower lip unicolor or mottled. . . . The labial spotting is infallible in distinguishing these two species."

It is of interest to note that although *Rana heckscheri* is considered to be a frog of rivers and streams (hence the common name "River Frog"), two of the North Carolina specimens were taken in lakes. Rhodes Pond, at the time the specimen

was collected, could best be described as a shallow cypress lake with little, if any, water movement. Greenfield Lake is also a cypress lake, fed by springs, and from which excess water flows into the Cape Fear River by a small outlet stream.

In addition to the above mentioned specimens, Alva Harris of the Carolina Biological Supply House, Elon College, N. C., has found a number of specimens of *Rana heckscheri* among frogs brought in by commercial collectors. One of these has also been verified as *R. heckscheri* by Mr. Neill (1958). Unfortunately, the exact area of collection remains a "trade secret" but it is believed that the specimens were taken either in the Cape Fear or Pee Dee River drainages in southern North Carolina.

The specimens discussed herein extend the range of the River Frog 175 miles northward of its previously reported limit at the Edisto River in South Carolina. Further collecting may reveal that it is far more common in southeastern N. C. than has been heretofore suspected.

The authors would like to express their appreciation to Mr. Neill for his assistance in identification and to Dr. Engels for his permission to incorporate the specimen from Sampson County.

LITERATURE CITED

BRIMLEY, C. S. 1943. Amphibians and reptiles of North Carolina. Reprinted from Carolina Tips (1939–43). Carolina Biological Supply Co., Elon College, N. C.

CHAMBERLAIN, E. BURNHAM. 1939. Frogs and toads of South Carolina. Charleston Mus. Leaflet No. 12, Charleston, S. C.

CONANT, ROGER. 1958. A field guide to reptiles and amphibians. Houghton Mifflin Co., Boston.

ENGELS, W. L. 1958. Information on a specimen of *Rana heckscheri* from Sampson County, N. C. Private communication.

NEILL, WILFRED T. 1958. Information on *Rana heckscheri* and *Rana catesbeiana*. Private communication.

SCHMIDT, KARL PATTERSON. 1953. A check list of North American amphibians and reptiles. Univ. Chicago Press, Chicago.

WRIGHT, A. H. 1924. A new bullfrog (*Rana heckscheri*) from Georgia and Florida. Proc. Biol. Soc. Wash. **37**: 141–152.

WRIGHT, ALBERT HAZEN, AND ANNA ALLEN WRIGHT. 1949. Handbook of frogs and toads of the United States and Canada. Comstock Publ. Co., Inc., Ithaca, N. Y.

SUMMER MARITIME BIRDS OF SOUTHEASTERN NORTH CAROLINA[1]

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Introduction

Studies of the maritime birdlife of southeastern North Carolina have been few and incomplete (Pearson, 1899, 1920, 1940; Fleisher, 1919; Metcalf, 1922; Burleigh, 1937; Wetmore, 1941). Information available through the year 1941 was summarized under the species accounts in the second edition of "Birds of North Carolina" (Pearson, Brimley, and Brimley, 1942).

Since 1945, members and guests of the Wilmington Natural Science Club have published numerous field notes on the transient and winter resident birds of the lower Cape Fear region in *The Chat* (Carolina Bird Club) and *Audubon Field Notes* (National Audubon Society). These have revealed a rich bird fauna in the non-breeding seasons.

The purpose of the present investigation was to determine the presence, residence status, relative abundance, and ecological distribution of the summer maritime birdlife inhabiting the ninety-five miles of coastline from New River Inlet in Onslow County to Little River on the North Carolina-South Carolina line. The field work was conducted in the summer of 1955.

The Area of Study

The coastal segment studied is ninety-five miles long but only one to three miles wide. The sea-coast habitats and communities included are those existing in close association with or under the causal influence of ocean surf, salt-water tides, and salt spray. The types of vegetation and ecological processes throughout the area are typical of those recently described in the review papers of Oosting (1954) and Penfound (1952) for the maritime strand and salt marshes of the southeastern United States. Maps, photographs, and additional ecological information about the region are also available in the literature (Boyce, 1954; Hamnett and Thornton, 1953; Engels, 1952; McAtee, 1939; Wells, 1939, 1942).

[1] Based on a thesis presented by the senior author in partial fulfillment of the requirements for the degree of Master of Science, Zoology Department, North Carolina State College, June, 1956.

Topographically, the transect on the ocean side is a linear series of thirteen narrow and sandy barrier islands or offshore banks alternating with an equal number of ocean inlets. Between the islands and the mainland is the continuous chain of narrow, shallow, and largely marsh-filled, salt- and brackish-water sounds through which the Inland Waterway was cut and dredged. From New River Inlet on the north to the mouth of the Cape Fear River the direction of the beach is southwest and the distance is sixty miles (North Carolina State Highway and Public Works Commission, 1956). The direction of the remaining thirty-five miles of beach from Fort Caswell to Little River is essentially due west. Smith Island proper, with its maritime forest (Wells, 1939) and the point of Cape Fear, was not studied, but the salt-marsh islands in the mouth of the Cape Fear River between Corncake Inlet and Southport were included (Adams and Quay, 1958).

This southeastern section of the North Carolina coastline has considerable topographic and ecologic distinctiveness. The 230 miles of coastal environment from Bogue Inlet (15 miles northeast from New River Inlet) to Virginia are more clearly known as North Carolina's "outer banks" (Stick, 1958) and are characterized by wider barrier islands, taller sand dunes, more extensive maritime forests and thickets, fewer and deeper inlets, and much wider and deeper sounds (Engels, 1942; Quay and Funderburg, 1958). From Little River to Pawley's Island in South Carolina, a distance of fifty miles, there are no barrier islands or salt marshes and the ocean beats directly on the mainland.

The mean annual temperature is 63.8 degrees F. The mean temperature for June-July-August is 78.9 degrees F. Annual precipitation is 49.84 inches. June, July (8.16 inches), August, and September are the wettest months, and November (2.59 inches) is the driest. The frost-free season is 250 days and the temperature is below freezing only twenty-six days a year. The prevailing winds are south-westerly. (Carney, 1955).

Methods

The senior author was in the field continuously all of June and July and frequently in August

and early September. The entire ninety-five miles were covered completely and the birds censused four different times. A number of spots were visited several additional times.

Only a small portion of the whole region was approachable by road, so access was principally by water. The boat used was a small, flat-bottomed bateau driven by a five-horsepower outboard motor and maneuverable in shallow, winding marsh channels. With car and trailer as operating base, the boat allowed overnight camping trips to locations where nesting colonies were large or plentiful.

Since most of the maritime species being considered were colonial birds of open habitat and relatively large size, the direct count method of population measurement was satisfactory (Kendeigh, 1944; Pettingill, 1956).

The small land birds (as opposed to marsh and water birds) present in some of the maritime habitats, such as mockingbird, prairie warbler, yellowthroat, and cardinal, were not included in this investigation.

Annotated List

The annotated list of all species and subspecies identified in the study area during the summer of 1955 is presented below in two sections—thirty breeding birds and twenty-three non-breeding birds. In addition, the cattle egret and the glossy ibis are included as two new and rare summer residents on the basis of breeding in the 1956, 1957, and 1958 seasons, though neither was recorded in 1955. Each species is described in two sets of entries. The first set, following immediately after the name and closed with a period, gives overall residence status and relative abundance in the region, based on the literature available, the authors' many years of personal field experience there, and the research outlined in this paper. The second set pertains only to the summer of 1955.

Designation of residence status is by the following terms: resident—present throughout the year; summer resident—present all summer (breeding season) and usually breeding; summer visitant—present only part of the summer and usually not breeding; winter resident—present all winter; winter visitant—present only part of winter; transient—migrating through in spring, or fall, or both.

The terms used to indicate relative abundance are: common—of regular occurrence in moderate to large numbers; uncommon—of regular occurrence in rather small numbers; rare—usually of irregular occurrence and in very small numbers. These terms necessarily imply somewhat different absolute numbers in different species, and are used with due consideration of habits and conspicuousness (Stewart and Robbins, 1958: 38).

All scientific and common names of birds are in accordance with the fifth edition of the "Checklist of North American Birds," (American Ornithologists' Union, 1957).

Breeding Birds

Green Heron, *Butorides virescens*—common summer and rare winter resident. Nests: Rich's Inlet, 17; Battery Island, 4; Aerlie Lake, 6; four specimens.

Little Blue Heron, *Florida caerulea*—common summer and uncommon winter resident. Nests: Rich's Inlet, 40; Battery Island, 34; two specimens.

Cattle Egret, *Bubulcus ibis*—rare and new summer resident; the first record of the cattle egret breeding in North Carolina was in the Battery Island heron colony in 1956 (Quay and Adams, 1956). Not seen in 1955.

Common Egret, *Casmerodius albus*—common summer and uncommon winter resident. Nests: Rich's Inlet, 105; Battery Island, 116; two specimens.

Snowy Egret, *Leucophoyx thula*—common summer and uncommon winter resident. Nests: Rich's Inlet, 132; Battery Island, 70; one specimen.

Louisiana Heron, *Hydranassa tricolor*—common summer and rare winter resident. Nests: Rich's Inlet, 198; Battery Island, 159.

Black-crowned Night Heron, *Nycticorax nycticorax*—uncommon resident. Nests: Battery Island, 5; Aerlie Lake, 7.

Least Bittern, *Ixobrychus exilis*—uncommon summer and rare winter resident. Seen in marshes immediately north of Carolina Beach, but not elsewhere; a clutch of four locally raised young birds seen July 19; two specimens.

Glossy Ibis, *Plegadis falcinellus*—rare and irregular summer resident; fifteen pairs nested in the Battery Island colony in 1956 (Quay and Adams, 1956); one pair found nesting in this colony in 1940, the first time north of Florida (Pearson, Brimley, and Brimley, 1942: 39). Not recorded in 1955.

Bald Eagle, *Haliaeetus leucocephalus*—rare resident. One nest in tall loblolly pine (*Pinus*

taeda) on mainland near Masonboro Inlet; this nest started in 1953; the adult eagles have returned each spring and added to nest but produced no eggs.

Osprey, *Pandion haliaetus*—common summer and rare winter resident. Nests common in pine forests bordering mainland; adults foraged over sounds and along beaches.

Northern Clapper Rail, *Rallus longirostris crepitans*—common summer and uncommon winter resident, from Cape Fear northward. An adult male taken near Carolina Beach on July 11 and an adult female with twelve young seen near Rich's Inlet on June 8 were typical of this subspecies; many heard during summer; two specimens.

Wayne's Clapper Rail, *Rallus longirostris waynei*—uncommon summer resident, from Cape Fear westward (Adams and Quay, 1958); winter status uncertain. Two very dark birds seen feeding together near Little River on June 29 appeared to be typical *waynei*.

American Oyster-catcher, *Haematopus palliatus*—uncommon resident. One nesting pair on nearly every dredge lump; one or more pairs around each inlet; one specimen.

Wilson's Plover, *Charadrius wilsonia*—common summer and rare winter resident. One or more pairs nested near the edge of every least tern colony; 75 nests found; two specimens.

Willet, *Catoptrophorus semipalmatus*—common summer and rare winter resident. Most common shorebird; 43 nests found, apparently many more not located; one taken on June 21 near Mason's Inlet and another near Fort Fisher on June 22 had adult plumage and completely ossified skulls but undeveloped testes, so all summer-resident willets did not breed; two specimens.

Laughing Gull, *Larus atricilla*—common summer and rare winter visitant. One young bird just able to fly, accompanied by two adults, near Elmore's Inlet on June 20 was only evidence of nesting; one specimen.

Gull-billed Tern, *Gelochelidon nilotica*—rare summer resident. Three nesting localities: Masonboro Inlet, June 16 (3 nests); Mason's Inlet, June 20 (1 nest); Carolina Beach, June 24 (1 nest); all five nests in colonies of least terns and black skimmers; one specimen.

Least Tern, *Sterna antillarum*—common summer resident. Thirteen colonies of least terns were studied, varying from four nests on Masonboro Sound on June 8 to 117 nests near Carolina Beach on June 24; total of 512 nests found; two specimens.

Black Skimmer, *Rhynchops nigra*—common summer and rare winter resident. Nests, all associated with least tern colonies: Myrtle Grove Sound, 1; Corncake Inlet, 14; Masonboro Inlet, 16; Mason's Inlet, 3; Carolina Beach, 6.

Mourning Dove, *Zenaidura macroura*—common transient and resident. Common on partially vegetated sand lumps, barrier islands, and edges of salt marshes; several nests in shrubbery, small trees, and on the ground.

Great Horned Owl, *Bubo virginianus*—uncommon resident, nesting on the mainland and foraging to some extent over the salt marshes (Funderburg and McAllister, 1951). One nest each in mainland woods bordering Greenville Sound, Masonboro Sound, and near Kure's Beach.

Florida Common Nighthawk, *Chordeiles minor chapmani*—common summer resident. Common on partially vegetated sand lumps, Fort Fisher northward; an adult female and eggs collected on Zeke's Island, mouth of Cape Fear River; two specimens.

Belted Kingfisher, *Megaceryle alcyon*—common transient and uncommon resident. Two nest holes in bank on Walden's Creek near Southport July 7, but undetermined whether in use.

Barn Swallow, *Hirundo rustica*—common summer resident. Common from Sear's Landing to Southport; twenty-one nests under drawbridge at Sear's Landing June 14, six nests in a boathouse on Middle Sound June 23, and some birds still feeding young in nests under drawbridge at Fort Caswell July 7; rare west of Fort Caswell.

Southern Common Crow, *Corvus brachyrhynchos paulus*—common resident. Common near wooded tracts of mainland, with a few individuals reaching nearby open beaches and salt marshes; probable cause of heavy predation on clapper rail nests near mainland.

Fish Crow, *Corvus ossifragus*—common resident. Common, especially around nesting colonies of shorebirds, terns, and herons; several nests in heron colonies; predation on eggs of maritime birds heavy.

Wayne's Long-billed Marsh Wren, *Telmatodytes palustris waynei*—uncommon summer resident. Locally common from Southport northward; no intergradation noted between *griseus* west of the Cape Fear River and *waynei* north of it (Wetmore, 1941).

Worthington's Long-billed Marsh Wren,

Telmatodytes palustris griseus—rare summer resident. Three nests with eggs and three specimens collected near Little River Inlet June 28–29, for the first breeding record in North Carolina; probably nests eastward to Cape Fear; three specimens.

Red-winged Blackbird, *Agelaius phoeniceus*—common resident. Most common passerine breeding bird of the salt marshes; nested in grasses, shrubs, and small trees; fed almost entirely in the salt marsh, usually searching for food on the vegetation.

Boat-tailed Grackle, *Cassadix mexicanus*—common resident. Nested in small colonies in a number of localities; fed primarily on the small marine animals of the mud flats, sand bars, and shallow pools; two specimens.

Macgillivray's Seaside Sparrow, *Ammospiza maritima macgillivraii*—common summer and rare winter resident. Common from Southport northward but absent from about two miles west of Fort Caswell to South Carolina because of unsuitable habitat; most common from Sear's Landing north to New River Inlet, where 327 were counted on June 25; sixteen specimens.

Non-breeding Birds

Pied-billed Grebe, *Podilymbus podiceps*—common transient and winter resident. One adult seen near Tubb's Inlet June 29.

Brown Pelican, *Pelecanus occidentalis*—uncommon summer resident and rare winter visitant. Thirty-two seen from June 16 to July 9 at several localities.

Double-crested Cormorant, *Phalacrocorax auritus*—common winter and rare summer resident. Two at Masonboro Inlet June 8; one at mouth of Shallotte River June 30.

Great Blue Heron, *Ardea herodias*—uncommon resident. Fed to some extent in the salt marshes, but apparently nested only in freshwater locations.

Wood Ibis, *Mycteria americana*—rare and irregular summer visitant. At least 16 in the vicinity of Little River June 28; two near mouth of Shallotte River July 1.

Red-breasted Merganser, *Mergus serrator*—common winter and rare summer resident. One immature bird near Shallotte June 9, another near Mason's Inlet June 30; two adult males near Masonboro Inlet June 8.

Turkey Vulture, *Cathartes aura*, and Black Vulture, *Coragyps atratus*—common residents. Only five turkey vultures and no black vultures were seen in the summer of 1955, though in other years both species have been common along the ocean beaches and sound edges.

King Rail, *Rallus elegans*—rare resident; a fresh-water marsh species that occasionally enters the salt marsh, especially in winter. One flushed from a clump of *Spartina alterniflora* near Sear's Landing June 14, with two clapper rails.

Piping Plover, *Charadrius melodus*—common transient and rare summer resident. One near Masonboro Inlet June 8; no evidence of nesting.

Black-bellied Plover, *Squatarola squatarola*—common winter resident and rare summer visitant. Six seen in June and four in July; two specimens.

Ruddy Turnstone, *Arenaria interpres*—common transient and rare winter and summer visitant. One adult in full plumage near Masonboro Inlet June 8.

Common Snipe, *Capella delicata*—common transient and rare winter resident. Four seen feeding on a muddy, burned area of *Spartina alterniflora* marsh near Carolina Beach June 10 was the first record of this species in summer in North Carolina.

Whimbrel, *Numenius phaeopus*—rare transient and winter visitant. One near Mason's Inlet June 20; one at Fort Fisher June 22.

Spotted Sandpiper, *Actitis macularia*—common transient and rare winter and summer visitant. One near Tubb's Inlet June 29.

Solitary Sandpiper, *Tringa solitaria*—common transient and rare summer visitant. Four in June and five in July, various dates and localities.

Least Sandpiper, *Erolia minutilla*—common transient, uncommon summer and rare winter visitant. Sixty-eight in June, five in July; four specimens collected, all in non-breeding condition.

Marbled Godwit, *Limosa fedoa*—uncommon transient and rare winter and summer visitant. Fourteen at Fort Fisher June 22, three near Carolina Beach June 24; two specimens.

Herring Gull, *Larus argentatus*—common winter and uncommon summer resident. Six adults together near Mason's Inlet June 20; small numbers of immature birds at various localities throughout the summer.

Ring-billed Gull, *Larus delawarensis*—common winter resident and rare summer visitant. One adult near Sear's Landing June 14.

Common Tern, *Sterna hirundo*—common transient and rare summer visitant. Seventeen in

June, none in July; intensive search for nests was unsuccessful.

Royal Tern, *Thalasseus maximus*—uncommon summer and rare winter resident. Small numbers all along coast, but no evidence of nesting; one specimen.

Caspian Tern, *Hydroprogne caspia*—rare summer and winter visitant. Twenty-three seen during June, usually around the ocean inlets with royal terns; four in July; no evidence of nesting.

Chuck-will's-widow, *Caprimulgus carolinensis*—uncommon summer resident. Seventeen heard near Little River June 28, where barrier-island and salt-marsh complex is interrupted by well-developed woodland; none heard elsewhere along coast, though common on adjacent mainland.

NESTING HABITATS OF BREEDING BIRDS

All nesting species are arranged below in their respective breeding habitats. Dominant plant species of each habitat are listed by scientific name.

1. Bare sand and shell, of beach, sand flat, dune, and dredge lump: Wilson's plover, least tern, gull-billed tern.

2. Partially vegetated sand and shell, of dune and dredge lump; *Uniola paniculata, Spartina patens, Fimbristylis castanea, Andropogon* spp., *Strophostyles helvola:* oyster-catcher, willet, gull-billed tern, black skimmer, mourning dove, nighthawk.

Most of the birds of these first two habitats are colonial and all nest on the ground. These species were commonest in the thirty-five miles from Corncake Inlet to New Topsail Inlet, where the inlets, islands, sand flats, and dredge lumps were more frequent and less disturbed.

3. Salt marsh, mainly in the vicinity of the drift line (Hunter and Quay, 1953); flooded twice daily; *Spartina alterniflora, Spartina patens, Juncus roemerianus, Distichlis spicata, Borrichia frutescens, Iva frutescens, Baccharis halimifolia:* least bittern, clapper rail, long-billed marsh wren, seaside sparrow.

4. Shrub thicket, usually bordered by grass-shrub or salt-marsh communities; *Myrica cerifera, Ilex vomitoria, Juniperus virginiana:* green heron, mourning dove, red-winged blackbird.

5. Thicket woodland, on small islands bordered with salt marsh; *Quercus virginiana, Juniperus virginiana, Myrica, Ilex, Persea borbonia:* common egret, snowy egret, cattle egret, Louisiana heron, little blue heron, black-crowned night heron, green heron, glossy ibis, fish crow, boat-tailed grackle.

6. Tall pine trees, at mainland edge of salt marsh; *Pinus taeda:* bald eagle, osprey, great horned owl, common crow. (Kingfisher in dirt bank at mainland edge).

7. Man-made structures, as bridges, boats, and houses: barn swallow.

SUMMARY

The summer maritime birdlife of ninety-five miles of southeastern North Carolina coastline was studied in 1955. Thirty species were recorded as breeding and twenty-three as present but not breeding. Residence status and relative abundance are given for all species in an annotated list. The nesting habitats of the breeding birds were: bare sand and shell areas, partially vegetated sand and shell areas, salt marsh, shrub thicket, thicket woodland on small islands surrounded by salt marsh, tall pines at mainland edge of salt marsh, and man-made structures. Common nesting species were the common egret, snowy egret, Louisiana heron, little blue heron, green heron, osprey, clapper rail, Wilson's plover, willet, least tern, black skimmer, mourning dove, nighthawk, barn swallow, common crow, fish crow, red-winged blackbird, boat-tailed grackle, and seaside sparrow.

LITERATURE CITED

ADAMS, DAVID A. AND THOMAS L. QUAY. 1958. Ecology of the clapper rail in southeastern North Carolina. Jour. Wildl. Man. **22:** 149–156.

American Ornithologists' Union. 1957. Check-list of North American Birds. Fifth Ed. American Ornithologists' Union: Baltimore.

BOYCE, STEPHEN G. 1954. The salt spray community. Ecol. Mon. **24:** 29–67.

BURLEIGH, THOMAS D. 1937. Bird life on the North Carolina coast. Auk **54:** 452–460.

CARNEY, CHARLES B. 1955. Weather and climate in North Carolina. N. C. State Coll., Agr. Exp. Sta. Bull. **396:** Pp. 1–47.

ENGELS, WILLIAM L. 1942. Vertebrate fauna of North Carolina coastal islands I. Ocracoke Island. Amer. Midl. Nat. **28:** 273–304.

———. 1952. Vertebrate fauna of North Carolina coastal islands II. Shackleford Banks. Amer. Midl. Nat. **47:** 702–742.

FLEISHER, EDWARD. 1920. Notes on the birds of southeastern North Carolina. Auk **37:** 565–572.

FUNDERBURG, JOHN B., JR. AND C. H. MCALLISTER. 1951. Notes on some unusual bird behavior. Chat **15:** 25–27.

HAMNETT, WILLIAM L. AND DAVID C. THORNTON. 1953. Tar Heel Wildlife. North Carolina Wildl. Res. Comm: Raleigh. Pp. 1–98.

HUNTER, WANDA SANBORN AND THOMAS L. QUAY. 1953. An ecological study of the helminth fauna of Macgillivray's seaside sparrow, *Ammospiza maritima macgillivraii* (Audubon). Amer. Midl. Nat. **50:** 407–413.

KENDEIGH, S. C. 1944. Measurement of bird populations. Ecol. Mon. **14:** 67–106.

MCATEE, W. L. 1939. Wildlife of the Atlantic coast salt-marshes. U. S. D. A. Circ. No. 520. Pp. 1–28.

METCALF, Z. P. 1922. The birds of the Cape Fear region of the North Carolina coast. Wilson Bull. **34:** 28–34.

North Carolina State Highway and Public Works Commission. 1956. Official highway map. Raleigh.

OOSTING, HENRY J. 1954. Ecological processes and vegetation of the maritime strand in the southeastern United States. Bot. Rev. **20:** 226–262.

PEARSON, T. GILBERT. 1899. Notes on some birds of eastern North Carolina. Auk **16:** 246–250.

———. 1920. Exploring for new bird colonies. Bird-Lore **22:** 255–262.

———. 1940. North Carolina bird colonies. Auk **57:** 423–424.

———, C. S. BRIMLEY, AND H. H. BRIMLEY. 1942. Birds of North Carolina. N. C. Dept Agr.: Raleigh.

PENFOUND, WILLIAM T. 1952. Southern swamps and marshes. Bot. Rev. **18:** 413–446.

PETTINGILL, O. S., JR. 1956. A Laboratory and Field Manual of Ornithology. Third Ed. Burgess Publ. Co.: Minneapolis.

QUAY, THOMAS L. AND DAVID A. ADAMS. 1956. Nesting of cattle egrets and glossy ibises in the Battery Island rookery at Southport, N. C. Chat **20:** 56–57.

——— AND JOHN B. FUNDERBURG JR. 1958. The cattle egret in North Carolina. The Raven **29:** 115–117.

STEWART, ROBERT E. AND C. S. ROBBINS. 1958. Birds of Maryland and the District of Columbia. N. A. Fauna No. 62. U. S. Fish and Wildl. Serv.: Washington, D. C.

STICK, DAVID. 1958. The Outer Banks of North Carolina 1584–1958. Univ. N. C. Press: Chapel Hill.

WELLS, B. W. 1939. A new forest climax: the salt spray climax of Smith Island, N. C. Bull. Torrey Bot. Club **66:** 629–634.

———. 1942. Ecological problems of the southeastern United States coastal plain. Bot. Rev. **8:** 533–561.

WETMORE, ALEXANDER. 1941. Notes on the birds of North Carolina. Proc. U. S. Nat. Mus. **90** (3117): 483–530.

A PRELIMINARY EXPERIMENT IN SWINE TO DETERMINE THE EFFECTIVENESS OF CADMIUM OXIDE AGAINST *TRICHINELLA SPIRALIS*

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In previous reports (Larsh and Goulson, 1957; Larsh *et al.*, 1958), it was shown that medicated feed in pellet form, containing 0.015 per cent cadmium oxide, had a striking effect against *T. spiralis* in mice. It was of particular interest that by the continuous use of this feed the burden of muscle larvae remained at a low level despite repeated infections. These results, therefore, encouraged the present study to determine the effectiveness of this chemical in the important reservoir, the hog.

In considering the present experiment, it seemed necessary to follow as closely as possible the design and procedures used in our most recent mouse study, regardless of the obvious difficulties in obtaining a quantitative appraisal of the parasite burden in such a large host. Since no references were found with information applicable directly to the present study, the methods described below were those agreed upon after advice from associates working with large animals. Because of the nature of the problem, it seemed advisable first to perform a pilot experiment with small numbers of animals. The present report gives the results of this experiment.

MATERIALS AND METHODS

The experimental animals employed in this study were pigs of a mixed breed from a single litter. They were farrowed and maintained in a Quonset hut designed especially for experimental studies of this type. Drinking water was available at all times, and the pens, with a concrete floor, were washed daily with a garden hose.

A swine feed, fed routinely at the Animal Diseases Laboratory (see acknowledgments below), was the basic ration used in this study. To obtain the medicated feed with a concentration of 0.015 per cent cadmium oxide, one lb. of "Aska-Rid" (1.5 per cent cadmium oxide) was mixed with 100 lbs. of the basic ration. Uniform mixing was assured by using a large mechanical feed mixer. Both rations, entirely adequate in all respects, were provided *ad libitum* by means of steel self-feeders. As a check on the growth of the animals, they were weighed at weekly intervals. Notes were also taken concerning their general appearance and behavior.

The *T. spiralis* larvae used for infection were obtained from infected white mice of a stock colony maintained by this Department. The procedures for the isolation of the infective larvae were those described by Larsh and Kent (1949), with minor modifications. The pigs were infected by administering 10 ml. aliquots of a nutrient broth-gelatin mixture that contained the desired number of *T. spiralis* larvae. The mixture was given by a stomach tube (rubber rectal tube, french scale 20, 20 inches long) inserted through the opening of a mouth clamp used to keep the jaws well separated. Although difficulty in holding the animals for infection increased with their age, anesthesia was not used.

The methods for recovering and counting the larvae encysted in the musculature were as follows. After the animal was sacrificed, it was skinned and eviscerated, and the entire carcass was divided into equal halves. The right half of the carcass was processed, the remaining half was incinerated. In the processing, the fat was discarded and all muscle tissue was removed including that carefully trimmed from all bones.

The muscle was ground finely with a hand-operated sausage grinder. After grinding, the "meat" was weighed carefully to calculate the proper ratio of artificial gastric fluid for digestion. In all instances, five liters of artificial gastric fluid were used for the digestion of each kilogram of muscle tissue.

This mixture was placed in large stone jars (10 gallon capacity) in a 37.5°C. incubator. Agitation was provided by magnetic stirrers during the entire period of digestion. At the end of 24 hours, agitation was discontinued and the mixture was allowed to settle for four hours. After settling, the upper two-thirds of the entire

volume was removed by use of a siphon. The remaining material was strained through two thicknesses of cheesecloth into 250 ml. bottles and concentrated by centrifugation (1800 rpm, two minutes). This process was continued until the entire residue, containing the *T. spiralis* larvae from the half-carcass, was concentrated into a total volume of less than one liter. This was placed in a graduated pharmaceutical beaker, and water was added to the one liter mark.

Because of the large volume, it was not possible to follow the usual procedure of removing 0.1 ml. samples for counting the larvae. Instead, the following was adopted. Using a 20 ml. syringe and a short length (7 inches) of rubber tubing, encased in glass tubing of the same length to prevent twisting, the mixture was suspended uniformly by the pumping action of the plunger. After thorough mixing each time, three 20 ml. samples were withdrawn and placed in separate 50 ml. centrifuge tubes. The number of larvae contained in 0.1 ml. of each sample was determined by the usual procedures (Larsh and Kent, 1949). After determining the average number of larvae contained in the various 0.1 ml. samples, the number per half-carcass contained in the volume of one liter was estimated by multiplying this average by the dilution factor, 10,000 ×.

Experimental Procedures and Results

Five young pigs, four weeks old, were weaned and divided into three groups. The two experimentals (Group I) received the medicated feed with cadmium oxide and were infected with *T. spiralis*; the two infected controls (Group II) received the same infections, but were not medicated; the one animal in Group III served as a non-medicated, non-infected control as a check on the weight gain of the other animals. All animals were kept under similar conditions in adjacent pens of the same building.

The control animals (Groups II and III) were placed on the basic ration, while the two experimental animals (Group I) were started on the basic feed medicated with 0.015 per cent cadmium oxide. These feeds were given throughout the entire course of the experiment.

Seven days after beginning the respective diets, the two experimentals (Group I) and the two controls of Group II were infected with 10,000 *T. spiralis* larvae. Fourteen days after the first infection, a second infection with 20,000 larvae was given, and twenty-one days later, the last infection with 30,000 larvae was given.

After each of these three infections eight mice were infected with the same batch of larvae to check the infectivity. In all cases, the numbers of adult *T. spiralis* recovered seven days after infection were those expected for the dose used, indicating that the larvae used to infect the pigs had the usual infecting capacity.

Six weeks after the last infection, one animal from Group I and one control from Group II were sacrificed and the number of *T. spiralis* larvae encysted in the musculature was determined. Since facilities were limited, all animals could not be processed at the same time. Therefore, the remaining animals, one from Group I, one from Group II, and the one of Group III, were sacrificed one week later. The number of larvae recovered from the musculature of the individual swine of Groups I and II is recorded in Table I.

As shown in Table I, the experimentals (I) maintained on the medicated feed harbored an average of 129,580 larvae, while the infected controls (II) harbored an average of 1,781,233 larvae. Thus, there was more than a thirteen-fold reduction in the number of *T. spiralis* larvae encysted in the musculature of the swine that had received the feed medicated with 0.015 per cent cadmium oxide.

Also noted in Table I is the average total weight of the muscle tissue removed from the four infected animals. The average for the experimentals was 7,112 gms., and for the infected controls, 10,432 gms. Not shown in the table is the average (12,394 gms.) for the one uninfected animal of Group III. These averages reflect the difference in the total body weight of the five

TABLE I

The number of larvae recovered from the musculature of hogs 42 days after the last of three infections with T. spiralis

Group I (Experimentals) Medicated feed; infected with 10,000, 20,000 and 30,000 larvae. The second infection was given 14 days after the first, the third 21 days after the second.			Group II (Infected Controls) Non-medicated feed; infected with 10,000, 20,000 and 30,000 larvae. The second infection was given 14 days after the first, the third 21 days after the second.		
Hog	Weight of muscle (half-carcass)	Larvae recovered (half-carcass)	Hog	Weight of muscle (half-carcass)	Larvae recovered (half-carcass)
	gms.			*gms.*	
1	6,466	103,826	1	10,905	1,456,666
2	7,758	155,333	2	9,958	2,105,800
Av.:	7,112	129,580	Av.:	10,432	1,781,233

animals at necropsy. The two experimentals (I) averaged 100.5 lbs., and showed a gain of 76.5 lbs. during the experiment; the two infected controls (II) averaged 150.0 lbs., and had a gain of 131.0 lbs.; the one uninfected animal (III) weighed 160.0 lbs., and gained 141.0 lbs. during the experiment. It is clear that the medicated animals failed to gain at the same rate as the infected controls. Whether reduced food intake and/or the development of a trace mineral imbalance contributed to this is not known.

DISCUSSION

The comparatively small graded doses of larvae used for infections in this study were selected in an effort to simulate conditions in nature whereby swine are exposed at intervals to light infections. No outward effects of the infections were noted, as expected from earlier studies (Schwartz, 1938).

Although it is not possible to compare directly data obtained from different host species, it is of considerable interest to note the similarity between the present results and those obtained recently in mice (Larsh *et al.*, 1958). Following three graded infections (200, 300, 400 larvae) at 21-day intervals, the mice on the feed containing 0.015 per cent cadmium oxide had a total average of 2,901 muscle larvae, compared with 32,000 in non-medicated mice given the same infections. Thus, there was about an eleven-fold reduction in the medicated group. This compares favorably with about a thirteen-fold reduction noted in the experimental swine of the present experiment. In the mouse study, it was shown by adult worm counts that these reductions resulted from the combined effect(s) of acquired immunity and the anthelmintic action of the chemical. It would seem likely that the same was true in the present case.

On the basis of a half-carcass (Table I), the experimental swine fed the medicated feed had only 18.2 larvae per gram of muscle tissue, whereas the infected controls had 170.7. It is obvious that human consumption of improperly processed pork from the two sources would result in much milder infections in the case of the former. However, before advocating the use of this chemical in feed as a prophylactic to protect the health of swine and minimize the danger of acute human cases of the disease, much more information is needed. As the next step, it would seem advisable to repeat this experiment with larger numbers of animals and determine whether or not a smaller concentration of the chemical, and/or intermittent use of the chemical, will have a comparable inhibitory effect against the parasite without interfering with normal weight gain.

SUMMARY

The continuous use of a medicated feed, containing 0.015 per cent cadmium oxide, produced a striking reduction in the number of larvae recovered from the musculature of swine 42 days after the last of three infections with *T. spiralis*. It would appear from these results that additional tests in this important reservoir are desirable.

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LITERATURE CITED

LARSH, J. E., JR. AND H. T. GOULSON. 1957. The effectiveness of cadmium oxide against *Trichinella spiralis* in mice. Jour. Parasitol. **43:** 440–445.

———, ———, AND A. YARINSKY. 1958. The control of repeated infections with *Trichinella spiralis* in mice by the use of feed containing cadmium oxide. Jour. Elisha Mitchell Sci. Soc. **74:** 137–140.

LARSH, J. E., JR. AND D. E. KENT. 1949. The effect of alcohol on natural and acquired immunity of mice to infection with *Trichinella spiralis*. Jour. Parasitol. **35:** 45–53.

SCHWARTZ, B. 1938. Trichinosis in swine and its relationship to public health. Jour. Am. Vet. Med. Assn. **92:** 317–337.

INSECTICIDES COMBINED WITH HERBICIDAL OIL FOR THE CONTROL OF THE CARROT RUST FLY, *PSILA ROSAE* (F.) (DIPTERA: PSILIDAE)

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Introduction

Carrots, parsnips, and celery are severely injured by attacks of the carrot rust fly, *Psila rosae* (F.), in many areas of the northern United States and Canada. Stitt (1946) reported that DDT in herbicidal oil was used in Washington State to control the pest and the weeds in carrots. He, however, did not indicate the type of oil, the rate, the effectiveness, or the generation against which it was used.

The experiments herein reported were conducted from 1948 to 1952 at the Bradford Marshes, a muck area of approximately 7,000 acres, 40 miles north of Toronto, Ontario. The experimental control program was divided into two phases, the one dealing almost entirely with early or "bunching" carrots and the first generation of the insect; and the other with late or "storage" carrots and the second generation. The herbicidal oil-insecticide sprays were tested against the first generation of the pest only, because at the time of the appearance of the overwintered brood of flies, the weeds are small and the carrots are at the proper stage of development for spraying. This is usually about June 1. However, weather conditions in the area may change the date as much as a week.

Materials and Methods

The experimental design in 1948, 1949, and 1950 was a randomized block replicated four, four, and six times, respectively. In 1951 and 1952, the experimental design was a latin square. In 1948, 1949, and 1950 there were two checks; one was treated with oil only and the other was untreated. In 1948, 1949, and 1950 each plot contained six rows of carrots planted 16 inches apart, a total of 300 feet of row, approximately 0.01 acre. In 1951 and 1952 the plots were half this size.

The insecticides dissolved in herbicidal oil and their formulations, were as listed in Table I.

The insecticides were applied at two pounds actual toxicant per acre in 50 gallons of herbicidal oil, except lindane in 1948 when 1 pound only was used. The sprays were applied with a knapsack sprayer and were directed along the carrot rows. A fan-type spray nozzle, recommended for the application of herbicidal oils, was used.

A sample of 200 carrots was pulled from the center rows of each plot in each year, except 1951 when 150 carrots constituted a sample. These were washed, drained, weighed and examined for carrot rust fly injury. The data were subjected to an analysis of variance.

A composite sample of carrots from all plots of each treatment was taken for flavor tests each year.

The criterion for evaluating the effectiveness of the treatments was the number of infested roots at time of harvest.

Data showing differences at odds of 99:1 or over were said to be highly significant; whereas at odds of 19:1 or over they were described as significant.

Results

Table II summarizes the infestation data for the years 1948–1952.

1948.—Lindane, chlordane, and DDT were highly significant in their reduction of the number of injured roots as compared with the untreated checks. No phytotoxic effects were noted except in the DDT plots where severe foliage damage occurred. Plants in the injured plots, although at first damaged and stunted made good recovery in less than two weeks and showed no difference in yield at time of harvest. The samples submitted to the Department of Horticulture, Ontario Agricultural College, Guelph, Ontario, for flavor tests at time of harvest revealed no off-flavor.

1949.—Dieldrin and aldrin, which were added to the experiment this year, reduced the number of infested roots significantly when compared with chlordane, DDT, and both the check plots, where oil was applied and the untreated checks. Slight foliage damage was caused in the DDT and aldrin treated plots. No off-flavors were noted in any of the samples submitted at time of harvest.

TABLE I

Formulations of insecticides dissolved in herbicidal oil

Material	1948	1949	1950	1951	1952
Parathion			25% W.P.	25% Emul.	
Dieldrin		60% Powder	60% Powder	60% Powder	
Aldrin		60% Powder	60% Powder	20% Emul.	20% Emul.
Lindane	25% W.P.		25% W.P.	99.5% Pure	99.5% Pure
Chlordane	70% Tech.	70% Tech.	70% Tech.	40% Emul.	40% Emul.
DDT	Tech. Pure	Tech. Pure	Tech. Pure		
Check- oil only	A.W.K. #1*	A.W.K. #1	A.W.K. #1		
Check	Untreated	Untreated	Untreated	Untreated	Untreated

* A.W.K. #1—Stoddard solvent type of herbicidal oil produced by the Shell Chemical Corporation.

TABLE II

The effects of various insecticides in herbicidal oil on the infestation of carrot rust fly, Bradford, Ontario, 1948–1952

Treatment*	Average Number of Infested Roots				
	1948	1949	1950	1951	1952
Parathion	—	—	5.7	5.8	—
Dieldrin	—	4.8	4.0	19.0	—
Aldrin	—	4.0	5.0	31.7	0.4
Lindane	5.3	—	3.9	33.8	0.9
Chlordane	1.8	9.3	8.9	91.2	0.8
DDT	9.3	7.3	17.2	—	—
Check- oil† only	29.8	18.0	20.2	—	—
Check- untreated	43.0	33.8	21.0	123.3	1.2
L.S.D. 19:1	23.9	26.6	13.8	19.1	‡
L.S.D. 99:1	33.6	36.8	18.6	25.8	‡

* Two pounds of actual toxicant was used each year except in 1948 when lindane was used at a rate of one pound actual toxicant per acre.

† A.W.K. #1—Shell Chemical Corporation.

‡ No significant difference.

TABLE III

Yield from plots treated with insecticides dissolved in herbicidal oils. Bradford, Ontario, 1948–52

Treatment	Average* yield of carrots per plot in pounds				
	1948	1949	1950	1951	1952
Parathion	—	—	28.1	33.3	—
Dieldrin	—	10.2	27.8	32.5	—
Aldrin	—	10.2	20.7	29.7	9.8
Lindane	12.8	—	27.8	30.7	9.8
Chlordane	12.3	11.0	27.5	26.5	10.4
DDT	10.8	13.0	20.7	—	—
Check- oil only	11.6	10.7	27.1	—	—
Check- untreated	11.0	10.2	20.5	24.0	10.6

* No significant differences.

1950.—Parathion, dieldrin, aldrin and lindane gave significant reductions in root injury when compared with chlordane, DDT, herbicidal oil and the untreated checks. The DDT treated plots showed slight foliage injury. The plants, however, fully recovered in less than 10 days. Samples of carrots submitted at time of harvest for flavor tests reported off-flavor of an objectionable nature in the parathion, chlordane and lindane treated plots.

1951.—Parathion, dieldrin, aldrin, lindane and chlordane treated plots, significantly reduced root injury when compared with the untreated checks. All plots showed slight foliage damage. Flavor tests reported the parathion-treated plots slightly off-flavor and the untreated checks inedible.

1952.—The infestation in this experiment was too light to give data of significance. No foliage damage was noted at time of application in any plot. No off-flavors were reported.

Yield data were recorded each year as shown in Table III. No significant difference was noted in any year between any two treatments or the checks.

Herbicidal oils do retard growth when used at the above rates but this "set-back" is not reflected in subsequent yields.

DISCUSSION

Because parathion presented so many hazards to the workers, it was omitted from the program in 1952. It was unavailable in 1948 and available at Bradford as a dust only in 1949. Dieldrin, which was not available in 1948, was excluded from the program in 1952 because of its long

residual properties. This was an undesirable feature on a food crop such as carrots. Aldrin, although not available in 1948, was maintained throughout the remainder of the experiment. Lindane was maintained throughout the experiment, except in 1949, when the application of lindane, which is the gamma isomer of BHC, was a very controversial issue due to causing possible off-flavor in carrots or subsequent crops of Irish potatoes. DDT was omitted after the 1950 season because it was not giving consistent control of the carrot rust fly, and caused the most severe foliage damage each year. The check plots where herbicidal oil only was used were omitted from the experiment after 1950 because they did not cause a significant reduction in carrot rust fly injury or increase the yield. Chlordane reduced the number of infested carrots significantly each year; therefore, was used throughout the experiment.

When sprays were applied on a cloudy, cool day little or no damage occurred; whereas on hot, bright days, as in 1951, damage occurred.

Yields from none of the experiments showed significant differences between treatments regardless of the infestation. Therefore, the criterion of effectiveness of the treatments must be based on the number of infested carrots per sample.

Carrots develop side roots and other unusual forms which cause samples of infested carrots from different plots to have the same weight. On mineral soils, similarly infested carrots show yield differences. On muck soils, however, because of the ideal growing conditions these differences are not evident. This, of course, does not benefit the grower, because any carrot damaged by the carrot rust fly is unsaleable.

Summary and Conclusions

Commercial growers, especially, welcome any combination treatment because it reduces cost of production. The application of herbicidal oil to control weeds in carrots is now a routine operation.

Parathion, dieldrin, aldrin, lindane, chlordane and DDT gave significant reductions in the number of infested carrot roots at time of harvest when combined with herbicidal oil.

Foliage injury occurred consistently in the DDT-treated plots. In no instance, however, did the injury cause significant reductions in yield. Off-flavors were noted in chlordane, lindane and parathion-treated carrots, but not consistently.

With the marked advance in the use of herbicides and the development of better application equipment, combination sprays, in which insecticides are included should warrant further investigation.

Acknowledgments

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LITERATURE CITED

Stitt, L. 1946. Control of the carrot rust fly. Washington State Agric. Expt. Sta. Bull. **482**: 71.

DISTRIBUTION OF SOME LIGNICOLOUS ASCOMYCETES AND FUNGI IMPERFECTI IN AN ESTUARY

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Although marine fungi were known as early as 1845, subsequent studies on these organisms were limited both in intensity and purpose. This is immediately evident if one surveys the literature from 1845 to 1955 (Johnson and Meyers, 1957). Published studies on halophilous fungi have, for the most part, emphasized taxonomy and morphology, shown somewhat less emphasis on physiology, and revealed only a superficial understanding of the ecology of such organisms. The studies by Höhnk (1952, 1956), Harder and Uebelmesser (1955), Reynolds and Meyers (1958), and Siepmann (1957) are notable exceptions, since these investigators have at least explored certain aspects of marine fungus ecology.

Estuaries, affording as they do a gradient of environmental conditions, are admirably suited habitats for the study of aquatic fungus distribution. No investigation, however, has been aimed exclusively at revealing distributional patterns of lignicolous fungi in estuaries. Consequently, an exploratory study was initiated to examine the occurrence of lignicolous fungi in the Newport River, North Carolina. This lotic habitat, like all estuaries, is subject to periodic intermixing of fresh water and sea water. The primary aim was a study of the influence of two hydrographic factors only—temperature and salinity—on the occurrence of lignicolous fungi.

Materials and Methods

Six collecting stations were initially established in the Newport River on the basis of a salinity gradient (0‰–35‰). Although the intensity of the gradient fluctuated during the course of the field work (36 weeks), a well-defined gradient average in salinity from station to station was maintained. One station was located in the fresh water portion of the river, and one in sea water, at the river mouth; the remainder were interspersed between these two stations approximately three and one-half kilometers apart. The minimum and maximum salinity at the sea water station (mouth of the estuary) was 26.9‰ and 37‰, respectively. Lignicolous fungi were collected by submerging basswood and sycamore panels (15 x 10 x 2 cm.) at the stations. The double panel "trap" designed by Meyers (1953) was used. Six panel "harvests" were made at six week intervals, and the panels subsequently examined for fungi. At the time of panel submergence and harvest, and at periodic intervals between, water temperatures and salinities were determined at the station sites. Salinities were measured hydrometrically. The water samples for determining temperature and salinity were taken 1½ meters below the surface. The distance incorporated between the sea water and fresh water stations was 22 km.

Results

Five species of lignicolous Fungi Imperfecti and 18 ascomycetous species were collected. Members of the genera *Ceriosporopsis* Linder, *Lulworthia* Sutherland, *Lignincola* Höhnk, and an undescribed *Trichocladium* Harz were most frequently observed on the panels. Of these genera, *Lulworthia* (a so-called marine genus) was represented by the most species—five.

Distribution and salinity: The five representatives of the Fungi Imperfecti (*Phoma*, *Macrophoma*, *Piricauda*, *Stagonospora*, and *Trichocladium*) were largely distributed in the fresh and brackish water sectors of the estuary. No Fungi Imperfecti occurred in Newport River water having a salinity higher than 28.9‰. *Trichocladium sp.* had the widest salinity tolerance, 3.3–28.9‰, of the Imperfecti collected. *Macrophoma sp.*, *Phoma sp.*, and *Stagonospora sp.* occurred exclusively in fresh water.

Some of the lignicolous Ascomycetes showed a pronounced response, distributionally, to salinity. *Ceriosporopsis halima* Linder did not occur in any portion of the estuary having waters of a salinity less than 15‰. Similarly, four species of *Lulworthia*, *L. floridana* Meyers, *L. grandispora* Meyers, *L. medusa* var. *medusa* (E. & E.) Cribb & Cribb, and *L. submersa* Johnson, were restricted in distribution to waters in which the salinity approached that of "normal" sea water (35‰). *Lulworthia salina* Linder, on the contrary,

occurred in waters as low as 3.3‰ salinity. The general range of salinity within which Lulworthias grew and produced ascocarps was 28–36‰. *Leptosphaeria discors* (Sacc. & Ellis) Sacc. & Ellis and *Lignincola laevis* Höhnk developed on wood submerged at stations throughout the entire esturarine salinity range—0–36‰. Both species have been described previously as marine fungi. *Torpedospora radiata* Meyers, also reputed to be a "marine" fungus was found in both the fresh water and sea water sectors of the estuary.

With regard to salinity, the most prominent hydrostatic stress in an estuary, the lignicolous fungi collected showed a distributional propensity for one of three sectors of the estuary: (1) *Ceriosporopsis hamata* Höhnk, *Leptosphaeria albopunctata* (West.) Saccardo, *Metasphaeria australiensis* Cribb & Cribb, *Macrophoma sp.*, *Phoma sp.*, *Stagonospora sp.*, *Phomatospora sp.*, and *Sphaerella sp.*,—fresh water; (2) *Ceriosporopsis halima*, *Lulworthia floridana*, *L. grandispora* var. *grandispora* Meyers, *L. medusa* var. *medusa*, *L. submersa*, *Mycosphaerella sp.*, *Pleospora sp.*, and *Sphaerulina orae-maris* Linder—sea water; (3) *Ceriosporopsis cambrensis* Wilson, *Lulworthia salina* Linder, *Leptosphaeria discors*, *Lignincola laevis*, *Piricauda pelagica* Johnson, *Torpedospora radiata*, and *Trichocladium sp.*—fresh, brackish, and sea water. Among these fungi, particularly in groups one and three, are species previously described as "marine" forms.

Distribution and temperature: The full range of water temperatures in the Newport estuary during the 36 week duration of the study was 4–32° C. As would be expected, lignicolous fungi were more abundant during the months in which the water temperature ranged from 25–32° C. than when the mean water temperature was lower. Obviously, the density of the individual species, tallied as fructification abundance, may be a measure of the effect of temperature on fungal growth. In general, fruiting colonies of lignicolous Ascomycetes were notably less abundant than those of Fungi Imperfecti, even though the Imperfects were represented by only three species, in water at temperatures of 4–4.2° C. Colony density of Ascomycetes decreased as the water temperature fell; conversely, the density and number of deuteromycetous colonies, on the wood surfaces, increased over that of ascomycetous species as temperature declined. Some lignicolous fungi occurred in waters throughout the temperature range; *Lulworthia medusa* var. *medusa* was notable in this respect. Water temperatures, *per se*, ostensibly did not limit the distribution of *Ceriosporopsis cambrensis*, *C. halima*, *Lignincola laevis*, *Lulworthia floridana*, and *Piricauda pelagica* in the range of 8–32° C.

Perhaps the most singular results obtained were those showing a very pronounced distributional pattern of *Ceriosporopsis halima*, *C. cambrensis*, *Lulworthia submersa*, *L. floridana*, and *Trichocladium sp.* in response to the dual stress of water temperature and salinity. The distributional pattern of these species was, of course, determined from the presence, or absence, of visible ascocarps on and in the wood panels. Figure 1 shows the occurrence of three of the Ascomycetes, and one member of the Fungi Imperfecti in relation to salinity and temperature. The data for the distribution of *Trichocladium sp.* (Fig. 1) were taken from collections from the Neuse River, an estuary adjacent to the Newport River. The fungus had a strikingly similar distribution in the Newport estuary.

The points plotted in Figure 1, for each of the four fungi, represent the mean temperature-salinity level of the water at the time of collection. Even a cursory study of the data (Fig. 1) shows that four species at least, can be found in waters of higher salinity only at warmer water temperatures.

Ceriosporopsis cambrensis occurred on submerged panels when the water temperature was 8.5° C. and the salinity was 8.8‰. But, at the same water temperature, in higher salinities, the fungus was not collected. When the water temperature reached 12° C., on the contrary, *C. cambrensis*, occurred on panels submerged in waters with a general salinity range of 21–26‰. It was not until temperatures ranged from 25–30° C., however, that *C. cambrensis* occurred in waters approaching a salinity nearer that of sea water (30.6‰). *Ceriosporopsis halima* had a similar distributional pattern (Fig. 1).

Lulworthia floridana, seemingly restricted to higher salinity waters, also was distributed, in terms of submerged panel collections, in patterns indicative of a dual temperature-salinity stress. At 8° C., *L. floridana* occurred in waters at a salinity of 26.9‰ but not in more saline waters (Fig. 1) at the same temperature. Only when the temperature reached 25–29° C. did the fungus occur in waters with a salinity between 35.9 and 37‰.

The distribution of *Trichocladium sp.*, in both the Newport and Neuse estuaries, is even more striking than that of the other species since the

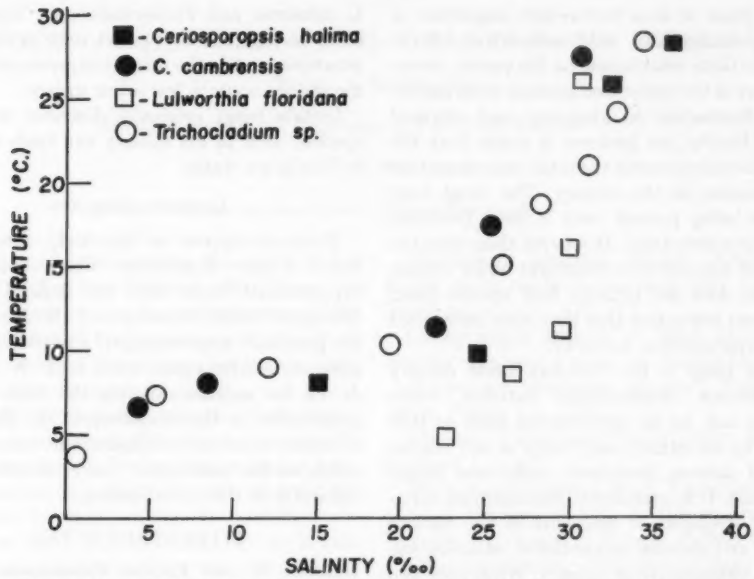

FIG. 1. Distribution of four lignicolous fungi in estuaries, in relation to water temperature and salinity.

salinity tolerance range of the fungus is so broad (0–34‰). At 4° C., water temperature, *Trichocladium sp.* was found only in the fresh water portion of the estuaries. At 7° C., the fungus occurred in waters with a salinity of 5‰, and at 8.7° C. the same species was collected at stations in waters of 11–13‰ salinity. As the water temperatures rose beyond 12° C., the fungus occurred in more saline waters: at 15° C., in 26‰ salinity; at 21° C., in 31‰ salinity, and at 28° C., in 34‰ salinity.

DISCUSSION

The initial question proposed for the study was: are marine fungi distributed in any pattern in an estuary? The results of this exploratory investigation, however, indicate more than is implied in the question, namely, that both temperature and salinity operate as dual factors in controlling the distribution of some marine and fresh water fungi in an estuary.

The results reported in the previous section may be compared to those recorded by Ritchie (1957) who investigated the influence of temperature and salinity on the growth of some marine fungi in agar culture. He showed experimentally that an unidentified marine species of *Phoma* and one of *Pestalotia* would not grow at temperatures below 6–7° C. on any concentration of salt water media used. He also found that "optimum" salinities for these organisms existed, but significantly, the salinity "optima" were affected by temperature changes. Ritchie stated this dual relationship in the following way (1957, p. 873): "Growth at low temperature proceeds fastest when the salinity is low, or at high temperature when the salinity is high."

In the natural, complex environment of an estuary, a similar temperature-salinity stress influences the distribution of some lignicolous fungi (Fig. 1). This is field confirmation, although with different fungal species, of the results reported by Ritchie, from laboratory studies.

There are two limitations in the study reported that must be emphasized. First, the temperature and salinity records were not taken from daily observations, but do represent acceptably accurate general ranges. Secondly, the environmental conditions extant at the time the fungi were harvested on panels were undoubtedly not the precise ones that existed during the total growth period of the fungi. Methods for rapid analysis of fungal populations in an estuary obviously must be devised. Thirdly, it should be noted that the distribution of estuarine fungi may be the function of additional hydrographic and hydrobiological factors not considered in this inves-

tigation. Some of these factors are: magnitude of currents, antagonistic and associative effects within the biota establishing on the panels, chemical factors of the water, and perhaps most significantly, fluctuation in chemical and physical stresses. Finally, no pretense is made that the fungi collected represent the total lignicolous fungal population in the estuary. The fungi were noted as being present only if they produced reproductive structures. It follows, then, that the absence of reproductive structures under certain conditions does not indicate that specific fungi were absent but rather that they may have failed to reach reproductive maturity.

Certain fungi in the Newport River estuary show distinct distributional patterns, while others do not. In an environment such as that afforded by an estuary, any factor or any combination of factors, doubtlessly influences fungal distribution. It is, manifestly, the continual variation and steepness of gradients of the various chemical and physical properties of estuarine waters that characterize an estuary. While only two of several environmental factors were studied—salinity and temperature—these appear to have a significant influence on the occurrence and distribution of fungi. They indeed may be the principal controlling factors in distribution.

The distribution of certain species, described as marine fungi, in the fresh water and low-salinity brackish water sectors of an estuary is prominent evidence of the fact that the salinity at which optimum growth and reproduction of a fungus occur, and not saline tolerance of that organism, should be used as one of several criteria for defining a marine fungus.

Summary

Lignicolous Ascomycetes and Fungi Imperfecti occurring in the Newport River, North Carolina, were studied to determine if distributional patterns for these organisms existed and if these patterns were affected by temperature and salinity. Five species of Fungi Imperfecti and eighteen species of Ascomycetes were collected during the nine months duration of the study. These species fall into three basic distributional types.

A dual stress of temperature and salinity apparently controls the distribution of *Ceriosporopsis halima*, *C. cambrensis*, *Lulworthia floridana*, *L. submersa*, and *Trichocladium sp.* These fungi occur in high salinity waters only at high temperatures, and as the water temperatures decline, the species occur in less saline waters.

Certain fungi, originally described as marine species, occur in low salinity and fresh waters as well as in sea water.

Acknowledgments

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LITERATURE CITED

Harder, R. and Esther Uebelmesser. 1955. Über marine saprophytische Chytridiales und einige andere Pilze vom Meeresboden und Meeresstrand. Archiv. Mikrobiol. **22**: 87–114.

Höhnk, W. 1952. Studien zur Brack- und Seewassermykologie I. Veröffent. Inst. Meeresforsch., Bremerhaven, **1**: 115–125.

———. 1956. Studien zur Brack- und Seewassermykologie VI. Über die pilzliche Besiedlung verschieden salziger submerser Standorte. Veröffent. Inst. Meeresfors., Bremerhaven. **4**: 195–213.

Johnson, T. W., Jr. and S. P. Meyers. 1957. Literature on halophilous and halolimnic fungi. Bull. Marine Sci. Gulf and Caribbean, **7**: 330–359.

Meyers, S. P. 1953. Marine fungi in Biscayne Bay, Florida. Bull. Marine Sci. Gulf and Caribbean, **2**: 590–601.

Reynolds, E. S. and S. P. Meyers. 1958. Salt water fungi. Annual Progress Report, Jan. 1, 1958, Office of Naval Research. (Mimeographed)

Ritchie, D. 1957. Salinity optima for marine fungi affected by temperature. Amer. Jour. Bot. **44**: 870–874.

Siepmann, R. 1957. Ein Beitrag zur saprophytischen Pilzflora des wattes der Wesermündung. pp. 1–88, appendix 1–30. Doctoral Dissertation, Christian Albrechts Universität: Kiel.

ADDITIONS TO THE FRESH-WATER ALGAE IN NORTH CAROLINA III[1]

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Since the publication of the last paper in this series by Phillips and Whitford (1958) there has been published a note by Schumacher (1958) which adds eleven taxa to the state list, ten of which are desmids. These taxa were from a single location in the coastal plain.

This paper represents material from recent collections made from all parts of the state. It includes new records for the state as well as noteworthy extensions within the state. The regions from which the taxa are reported and their abbreviations are: (M) mountain, (P) piedmont, and (CP) coastal plain. When the abbreviations appear without the parentheses they denote the range as reported by the current paper. Abbreviations appearing within the parentheses denote the range as previously reported.

Sixty taxa are added to the previous records. Extensions in range are made for twenty-seven taxa. Seven new genera are reported for the state. These genera are marked with an asterisk. One variety is a new taxon to science. These additions bring the number of fresh-water algae known in North Carolina to approximately 1025.

The authors wish to express appreciation to Dr. Francis Drouet, Dr. L. H. Flint, and Dr. Richard Wood for their determination of certain algae. Their proper acknowledgments appear throughout the following list.

Chlorophyceae

Ulotrichales.—*Draparnaldia plumosa* Agardh. Infrequent along edge of creek, Macon Co., M, (P).

Stigeoclonium lubricum var. *varians* (Hazen) Collins. On pebbles in rapids of brook, Johnston Co., CP.

**Gongrosira debaryana* Rabenh. On old bark and quartz pebbles in flowing brown water, Sampson Co., CP.

Chaetophora attenuata Hazen. Frequent as bright green beads on leaves in deep fast water Northampton Co., CP, (P).

Cylindrocapsa conferta W. West. In ooze and marshy area near a reservoir, Macon Co., M.

Microspora stagnorum (Kuetz.) Lagerh. In creek, Onslow Co., CP.

Microspora tenerrima (Kuetz.) Gay. In brook, Scotland Co., CP.

Microspora willeana Lagerh. Found only in one pond in Wayne Co. prior to this report. It has recently been found in a creek, Halifax Co., CP.

Chlorococcales.—*Golenkinia radiata* Chodat. Previously reported from a gold fish pond in Wake Co., (Whitford, 1956). It has since been found as rare in a moss *aufwuchs* in a brook in Wake Co., P.

Characium rostratum Reinhard. On *Microspora* entangled about stems in 1 foot of water, Sampson Co., CP.

Palmellococcus protothecoides (Krueger) Chodat. Abundant with Scenedesmus in a farm pond, Wake Co., CP.

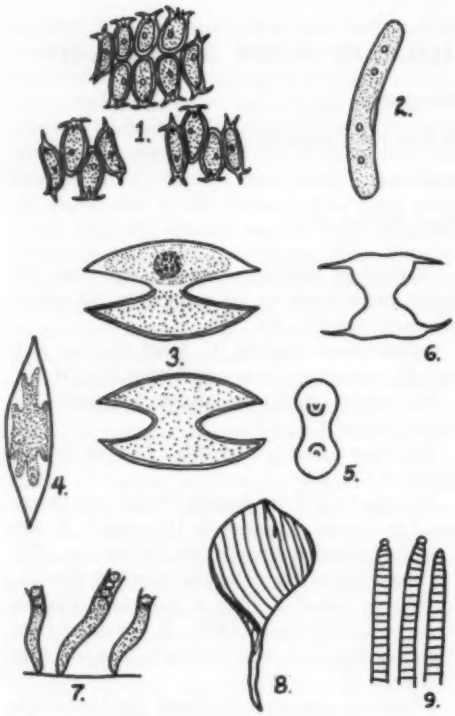
Scenedesmus arcuatus var. *platydisca* G. M. Smith. In brook, Johnston Co., CP.

Scenedesmus bijuga var. *alternans* (Reinsch) Hansgirg. In creek, Pitt Co., CP, (P).

Scenedesmus denticulatus var. *recurvatus* var. nov. Schumacher. Colonia 4–8 cellularum ovatarum que semi-ovatarum, in singulare aut alterna ordine. Cellulae apices cum 2–4 brevibus spinis. Spinis recurvatis praesertim in mediis cellulis. Cellulae 5–8 μ in diam., 12–15 μ in long. sine spinis. Spinis longis 3 μ, longioribus quam in typicus.

Colony of 4 or 8 ovate to ovoid cells arranged in a single or alternating series, apices of cells with 2–4 short spines (longer than in type), the spines recurving toward body of cell (especially those of central cells). Cells 5–8 micra in diameter, 12–15 micra long without spines, spines up to 3 micra in length. (Fig. 1). This variety differs from the type by its spines, which are longer and more greatly recurved.

[1] This work was supported by Contract No. AT-(40-1)-2100 with the Atomic Energy Commission's Division of Biology and Medicine.



EXPLANATION OF PLATE I

FIG. 1. *Scenedesmus denticulatus* var. *recurvatus* var. nov. ×500.

FIG. 2. *Roya obtusa* var. *montana* West & G. S. West. ×413.

FIG. 3. *Cosmarium lunatum* var. *depressum* West & G. S. West. Face view. ×583.

FIG. 4. *Cosmarium lunatum* var. *depressum* West & G. S. West. Top view. ×683.

FIG. 5. *Cosmarium lunatum* var. *depressum* West & G. S. West. End view. ×583.

FIG. 6. *Arthrodesmus ralfsii* W. West. ×665.

FIG. 7. *Chamaesiphon curvatus* Nordstedt. × 500.

FIG. 8. *Phacus tortus* (Lemm.) Skvortzow. ×363.

FIG. 9. *Oscillatoria agardhii* Gomont. ×500.

Frequent in creek 5 miles north of Beaulahville, Duplin Co., CP.

Scenedesmus serratus (Corda) Bohlin. In brook, Randolph Co., P.

Tetrastrum heteracanthum (Nordst.) Chodat. In net collections, Wayne Co., CP.

ZYGNEMATALES.—*Mougeotia opelousensis* Taft. Fruiting in pond, Aug. 15th, Gates Co., CP.

Cylindrocystis brebissonii var. *minor* Menegh. Infrequent in *Eunotia pectinalis* (Kuetz.) Rabenh. ribbons in a small spring, Macon Co., M.

Netrium oblongum var. *cylindricum* West & G. S. West. In a creek, Wayne Co., CP.

**Roya obtusa* var. *montana* West & G. S. West. Frequent in seeps and scrapings off rocks in fast water, Moore Co., P, and Jackson Co., M. (Fig. 2).

Closterium ehrenbergii Menegh. In creeks and large brooks, Harnett and Pitt Cos., CP.

Closterium incurvum Bréb. In creek, Bertie Co., CP (M).

Closterium parvulum Naeg. Rare in creek, Wake Co., P.

Closterium ralfsii var. *hybridum* Rabenh. Frequent in roadside ditch, Craven Co., CP.

Closterium turgidum Ehrenb. Frequent in creek. Size varied considerably. The largest cell being 870 micra by 83 micra. The striations were very fine and the pyrenoids numbered 8–10 in each semicell. Duplin Co., CP.

Pleurotaenium coronatum (Bréb.) Rabenh. An interesting species reported from a single location in Hyde Co., CP. A new station has been found in Price Canal, Pitt Co., CP.

Pleurotaenium ehrenbergii var. *granulatum* Ralfs. Infrequent in ooze and marshy area near a reservoir, Macon Co., M.

Pleurotaenium maximum (Reinsch) Lundell. In creek, Northampton Co., CP, (M & P).

Staurastrum alternans Bréb. In creek, Wake Co., P.

Staurastrum breviaculeatum G. M. Smith. Infrequent among plants along edge in quiet creek water, Johnston and Wayne Cos., CP.

Staurastrum margaritaceum (Ehrenb.) Menegh. In mill creek, Jackson Co., M.

Staurastrum punctulatum Bréb. Pool in ditch, Robeson Co., CP.

Staurastrum tetracerum Ralfs. In roadside ditch, Craven Co., CP.

Euastrum ansatum var. *pyxidatum* Delp. Rare in roadside ditch, Craven Co., CP.

Euastrum binale var. *gutwinskii* Schmidle. In with submerged aquatics in slow shallow water, Wayne Co., CP.

Euastrum denticulatum (Kirch.) Gay. In creek, Wake Co., CP.

Euastrum intermedium Cleve. Rare, in roadside ditch, Craven Co., CP.

Euastrum obesum var. *crassum* Prescott & Scott. In periphyton in slow shallow water of creek, Wayne Co., CP.

Euastrum verrucosum var. *alatum* Wolle. In brook, Johnston Co., CP, (P & M).

Micrasterias fimbriata Ralfs. In creek, Scotland Co., CP, (P).

Micrasterias mahabuleshwarensis var. *dichotoma* G. M. Smith. In creek, Harnett and Hertford Cos., CP.

Micrasterias papillifera Bréb. Frequent in seepage scum in rill, Macon Co., M.

Micrasterias radiosa var. *ornata* Nordst. In creek, Pitt Co., CP.

Cosmarium denticulatum forma *borgei* Irénee-Marie. In several creeks, Pitt Co., CP.

Cosmarium lunatum var. *depressum* West & G. S. West. Ditch in pocosin, Pender Co., CP, (CP). Entangled with filamentous green algae around *Utricularia*. Empty cells of this variety revealed that true spines are not present since the inner margin of the cell wall actually runs out into these projections. (Figs. 3, 4, & 5). This should be compared with Whitford's (1956) description and drawings. The cells from this collection averaged 24 micra in length, 40 micra in width, 7.5 micra at the isthmus and 12 micra in thickness.

Cosmarium phaseolus forma *minor* Boldt. In creek, Wake Co., P.

Cosmarium pseudotaxichondrum var. *foggii* Taylor. In roadside ditch. Craven Co., CP.

Cosmarium regnellii Wille. Frequent in creek, Wake Co., P.

Cosmarium subcrenatum Hantzsch. In brooks and creeks, Wake Co., P, and Johnston Co., CP.

Cosmarium turpinii Bréb. In with filamentous green algae on *Ludwigia* stems in brook, Johnston Co., CP.

Arthrodesmus ralfsii W. West. In creek, Pitt Co., CP. (Fig. 6).

Sphaerozosma granulatum Roy & Biss. Found in a ditch, creek and river in Scotland, Pitt, and Macon Cos., CP & M, (CP).

Charophyceae

CHARALES.—*Chara globularis* Thuill. Fruiting in clear brook originating from a small spring. pH = 6.8, temp. = 27°C. Dare Co., CP. (Ident. by R. D. Wood).

Euglenophyceae

EUGLENALES.—*Phacus suecicus* Lemmermann. New location in creeks in Columbus Co., CP and Wake Co., P, (CP).

Phacus tortus (Lemm.) Skvortzow. Rare in *Spirogyra* mat in creek, Martin Co., CP. (Fig. 8).

Xanthophyceae

RHIZOCLORIDALES.—*Stipitococcus vasiformis* Tiffany. In creek, Onslow Co., CP.

Ophiocytium parvulum (Perty) A. Braun. In roadside ditch, Craven Co., CP, (P).

HETEROTRICHALES. *Tribonema affine* G. S. West. Previous records have not stated a specific location. It has been found in a small brook, Wake Co., (P).

Chrysophyceae

CHRYSOMONADALES.—*Chrysosphaerella rodhei* Skuja. This species is new to the country. Found in plankton of a pond, Wake Co., P.

**Derepyxis dispar* (Stokes) Lemm. In seep, Wayne Co., CP.

RHIZOCHRYSIDALES.—*Chrysopyxis bipes* Stein. Abundant on all types of filamentous greens, especially *Mougeotia*, *Microspora* and *Oedogonium*, in pocosin ditch and brook, Bertie and Pender Cos., CP.

CHRYSOCAPSALES.—**Chrysocapsa paludosa* (W. & G. S. West) Pascher. Intermingled with *Sphagnum* and *Utricularia* in ditch, Pender Co., CP.

Phaeosphaera perforata L. Whitford. Widespread in winter and early spring especially in the Coastal Plain. At present known from twenty-one locations in twelve counties.

**Chrysostephanosphaera globulifera* Scherffel. Among *Sphagnum* at edge of pond, Carteret and New Hanover Cos., CP.

Cryptophyceae

CRYPTOMONADALES.—*Cryptomonas erosa* Ehrenb. Common in seep, Wayne Co., CP, (P).

Myxophyceae

CHROOCOCCALES.—*Anacystis montana* forma *minor* (Wille) Drouet & Daily. On soil seep, Watauga Co., M. (Ident. by F. Drouet).

Entophysalis rivularis (Kuetz). Drouet. Forming a crust on rocks in rapids of a creek, Wake Co., P. Also in creek rapids in Jackson and Swain Cos., M.

Chamaesiphon curvatus Nordstedt. Frequent in numbers, especially on mosses in current. Also found on *Oedogonium*. Avery, Jackson and Macon Cos., M. (Fig. 7), and Wayne County CP, in January.

OSCILLATORIALES.—*Oscillatoria agardhii* Gomont. Forming dark blue green mats in brooks. Trichomes interwoven and showing great varia-

tion in apex, some capitate, others not. Stanley, Co., P. On sticks in creeks, Macon Co., M. (Fig. 9).

Oscillatoria nigra Vaucher. On stems and wood in creek, Hertford and Tyrell Cos., CP.

Oscillatoria tenuis var. *tergestina* Rabenh. Forming blue green film on rocks in current in creek, Wake Co., P, (CP).

Lyngbya putealis Montagne. Forming a mat in creek, Macon Co., M. (Ident. by F. Drouet).

Schizothrix rivularis (Wolle) Drouet. In brook, Wake Co., P. (Ident. by F. Drouet).

Anabaena catenula (Kuetz.) Born. and Flah. In brook, Onslow Co., CP (Ident. by F. Drouet).

Anabaena subcylindrica Borge. Scrapings from plant stem in roadside ditch, Scotland Co., CP.

Anabaena torulosa (Carmichael) Lagerh. Frequent in a spring fed stream, Dare Co., CP, (P).

Scytonema guyanense (Mont.) Born. and Flah. In an aquarium in laboratory. (P).

Tolypothrix distorta (Fl. Dan.) Kuetz. On rocks in rapids of creek, Wake Co., CP. (Ident. by F. Drouet).

Amphithrix janthina (Mont.) Born. and Flah. Abundant, forming crust on rocks in creek rapids, Wake Co., P, (M).

Rhodophyceae

BANGIALES.—**Compsopogon coeruleus* (Balbis) Mont. On rock in rapids of Neuse River, Johnston County, CP.

NEMALIONALES.—*Audouinella violacea* (Kuetz.) Hamel. Now appears to be widespread in rapids of streams in M, P, and CP, (P), especially in winter in Coastal Plain.

Batrachospermum boryanum Sirodot. In brook in Wake Co., P. (Ident. by L. Flint).

Batrachospermum macrosporum Mont. Now found in 3 counties of the coastal plain, Bladen, Scotland, and Wayne, (CP). (Ident. by L. Flint).

Batrachospermum sirodotii Skuja. On stones in brooks of 2 counties, Stanley and Wake, P, (P). (Ident. by L. Flint).

Sirodotia suecica Kylin. In 2 brooks in Wake Co. and in a brown rocky stream in Moore Co., CP.

Lemanea fucina (Bory) Atkinson. On water-splashed dam. Jackson Co., M.

Tuomeya fluviatilis Harvey. Found in Anson, Jackson, Johnston and Wake Counties, M, P, and CP, (CP).

LITERATURE CITED

COCKE, E. C. 1949. The Myxophyceae of North Carolina. Jour. Elisha Mitch. Sci. Soc. **65:** 71–79.

FOREST, H. SILVA. 1954. Handbook of Algae. 467 pp. Univ. of Tennessee Press, Knoxville.

IRÉNEE-MARIE, F. 1938. Flore desmidiale de la region de Montreal. Laprairie, Canada.

PASCHER, A. 1913–1927. Die süsswasserflora Deutschlands, Österreichs und der Schweiz. Nos. 1–12. Jena.

PHILLIPS, R. C. AND L. A. WHITFORD. 1958. Additions to the fresh-water algae in North Carolina II. Castanea **23:** 25–30.

PRESCOTT, G. W. 1951. Algae of the Western Great Lakes Area. Cranbrook Institute of Science, Bull. No. 31. Bloomfield Hills, Mich.

SCHUMACHER, G. J. 1958. An unusual algal habitat. Jour. Elisha Mitch. Sci. Soc. **74:** 141–142.

SCOTT, A. M. AND R. GRÖNBLAD. 1957. New and interesting desmids from the Southeastern United States. Acta Societalis Scientiarum Fennicae, Nova Series B., II, No. 8.

SILVA, H. 1949. Additions to the algae of the Southeastern United States. Jour. Elisha Mitch. Sci. Soc. **65:** 90–109.

SKUJA, H. 1948. Taxonomie des phytoplanktons einiger einiger seen in Upland, Schweden. Symb. Bot. Upsalien. 9: 1–399.

SMITH, G. M. 1950. The fresh-water algae of the United States. McGraw Hill, New York.

WHITFORD, L. A. 1943. The fresh-water algae of North Carolina. Jour. Elisha Mitch. Sci. Soc. **59:** 131–170.

———. 1956. Additions to the fresh-water algae in North Carolina I. Trans. Amer. Micros. Soc. **75:** 196–203.

A RELICT PLANT COMMUNITY IN SOUTH CAROLINA[1]

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While making a systematic survey of the vascular plants in McCormick County, South Carolina, during early 1957 for the "Flora of the Carolinas" Project, I discovered a richly wooded area on the north slope of Stevens Creek, 1.5 miles northeast of Clarks Hill and nearly 20 miles by road northwest of Augusta, Georgia. The community proved to be so interesting floristically and ecologically that subsequent visits were made in 1957 and 1958 during each month of the growing season. Six state records, five species known from only one other locality in South Carolina and nineteen rare plants were found in this community.

The community is definitely mixed mesophytic. The composition of the canopy is approximately 25% *Carya cordiformis* (Wang.) K. Koch, 15% *Acer barbatum* Michx., 12% *Quercus prinus* L., 12% *Q. rubra* L., 10% *Ulmus rubra* Muhl., 8% *Celtis laevigata* Willd., 8% *Carya ovata* (Mill.) K. Koch, 3% *Juglans nigra* L., 2% *Liriodendron tulipifera* L., 2% *Liquidambar styraciflua* L., 2% *Ulmus alata* Michx., and 2% *Quercus alba* L. Most of the dominant trees are 16 to 20 inches in diameter; one black walnut measured 27 inches d.b.h. Cores obtained by the use of an increment borer indicate that the canopy oaks and hickories range from 175 to 250 years in age. The largest maple is 175 years old. *Ostrya virginiana* (Mill.) K. Koch is a rather striking subcanopy species, most of the specimens being from 8 to 11 inches in diameter. The transgressives are primarily *Acer barbatum*, *Quercus prinus*, *Q. alba*, and *Carya cordiformis*.

The shrubs are predominantly tall; some of the more abundant ones are *Lindera benzoin* (L.) Blume, *Asimina triloba* (L.) Dunal, *Philadelphus inodorus* L., *Staphylea trifolia* L., and *Aesculus sylvatica* Bartr. The most striking plant in the entire area is *Ribes echinellum* (Coville) Rehder, previously known only from Lake Miccosukee, Florida. This shrub forms a very thick spiny belt through the middle of the community.

The early spring herbaceous ground cover is colorful with *Isopyrum*, *Claytonia*, *Trillium*, *Tiarella*, *Dentaria*, *Dicentra*, *Geranium*, *Senecio*, and *Dodecatheon*. In March of 1958 the *Isopyrum* and *Claytonia* formed solid white mats near the base of the slope. Maroon, yellow, and white trilliums were abundant at lower elevations in the community; pink trilliums were uncommon. In one small area I counted over one hundred dodecatheons in bloom. The midsummer herbs were taller and less showy than the spring plants. Several species of *Desmodium*, *Agrimonia*, *Phryma*, *Helianthus*, and *Campanula* were common. In the fall goldenrods, asters, and eupatoriums were abundant in the community, although they suffered from the extremely dry weather of 1957 and 1958.

This is the only place in the state of South Carolina where *Sisyrinchium albidum* Raf., *Urtica chamaedryoides* Pursh, *Isopyrum biternatum* (Raf.) T. & G., *Dicentra cucullaria* (L.) Bernh., *Ribes echinellum* (Coville) Rehder, and *Lithospermum tuberosum* Rugel. are known to grow. Species found here that are known from only one other locality in the state are *Trillium lancifolium* Raf., *Euphorbia commutata* Engelm., *Dodecatheon meadia* L., *Campanula americana* L., and *Solidago notabilis* Mackenzie. Some rare South Carolina plants that are fairly abundant in this community are *Dryopteris marginalis* (L.) Gray, *Cystopteris fragilis* (L.) Bernh. var. *protrusa* Weath., *Brachelytrum erectum* (Schreb.) Beauv., *Carex pennsylvanica* Lam., *Trillium cernuum* L., *T. discolor* Wray, *Tradescantia hirsuticaulis* Small, *Corallorhiza wisteriana* Conrad, *Asarum canadense* L. var. *reflexum* (Bickn.) Robins., *Cerastium nutans* Raf., *Philadelphus inodorus* L., *Desmodium glutinosum* (Muhl.) Wood, *Staphylea trifolia* L., *Cubelium concolor* (Forst.) Raf., *Osmorhiza longistylis* (Torr.) DC., *Obolaria virginica* L., *Nemophila microcalyx* (Nutt.) Fisch. & Mey., *Eupatorium incarnatum* Walt., and *Senecio obovatus* Muhl. var. *elliottii* (T. & G.) Fern. These distribution data are based on a systematic survey of the flora in 42 of the 46 South Carolina

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counties, on herbarium studies, and on a search of the literature.

Another interesting vegetational feature of the Stevens Creek mixed mesophytic forest is the presence on the slope of many typical floodplain species. Some of these are *Uniola latifolia* Michx., *Pilea pumila* (L.) Gray, *Corydalis flavula* (Raf.) DC., *Asimina triloba* (L.) Dunal, *Lindera benzoin* (L.) Blume, *Staphylea trifolia* L., *Aesculus sylvatica* Bartr., and *Nemophila microcalyx* (Nutt.) Fisch. & Mey. In the Carolinas these floodplain plants are occasionally found off the alluvium on basic dikes in the piedmont, on carbonate outcrops in the mountains, and on marl outcrops in the coastal plain.

Why does such a unique assemblage of circumneutral plants with a mountain-cove aspect and with northern and southern affinities occur in an area just 12 miles northwest of the sandhills near the fall zone in the lower piedmont of South Carolina?

I believe this climax community to be a relic of a once wide-spread mixed mesophytic forest that grew in this area during the last glacial period of the Pleistocene. The temperatures are still low enough in the higher mountains of the Carolinas for the growth and development of this forest. In the lower piedmont of the Carolinas small remnants of this community occur on the cool, well-drained north slopes of rapidly down-cutting streams of the fall zone. Similar relict situations are found near capture points on a few streams in the central piedmont, and in the vicinity of the Triassic Basin where streams flow from the crystalline highlands into the sediments of the basin. On the coastal plain this forest community is found in a few places on the calcareous marls of the eastern counties. It is probable that many of the typically montane species described by Thomas Walter were discovered by him in the marl forests of Berkeley County. As species reach the limit of their ranges the more nearly optimum the edaphic conditions have to become. Optimum soil conditions in this area seem to be associated with basic rocks. In the Carolinas and elsewhere circumneutral soils are normally found on carbonate rocks, basic igneous dikes and calcareous marls.

The community in the Stevens Creek area and in a few other similar areas, however, occurs on soils derived from acid rock. The underlying rock here is syenite. The pH of the soil material within one inch of the rock is 4. In striking contrast, the pH of the melanized organic layer four to six inches above the rock ranges from 7 to 7.5. I think the pH tolerant dominants became established during a cooler glacial period. These species have returned enough bases and continue to return enough bases in the organic matter for the maintenance of the circumneutral topsoil in which most of the herbaceous species and some of the shrubs of distributional interest have their roots. This community has a northern exposure, a slope of 50 to 75 degrees, and excellent air and water drainage.

This unique combination of slope and soil factors in the Stevens Creek area accounts for the presence of the northern elements of the flora and for the relict nature of the community, while the circumneutral condition of the topsoil has provided a localized site for the invasion of some slightly basic pH species from the south as the temperature has risen during the last few thousand years. The resulting mixed mesophytic community has proved to be one of the most interesting in the Carolinas.

SPECIES NEW TO THE FLORA OF SOUTH CAROLINA

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This is the second in a series of papers on distribution of the vascular plants in the Carolinas in connection with the Flora of the Carolinas Project. Most of the records cited in this article are from the collections of the authors during 1957. Others are from the collections of O. M. Freeman and C. R. Bell, and a few noteworthy specimens were found in the local herbaria: University of North Carolina (NCU), North Carolina State College (NCSC), Duke University (DUKE), and the University of South Carolina (USC). The determinations of the legumes included in this paper were made by R. L. Wilbur of Duke University.

We presume 71 of the 72 taxa (67 species, 4 varieties, and 1 hybrid) enumerated in this report to be new records for the state of South Carolina. *Ranunculus muricatus* L. was reported by Thomas Walter (1788) from the vicinity of Charleston, but neither Benson (1948) nor we have seen a single herbarium specimen from South Carolina, so we are including our stations for the species.

The family arrangement follows that of Fernald (1950); genera and species are listed alphabetically. Unless otherwise noted by symbol, the specimens are deposited in the University of North Carolina Herbarium.

It is a pleasure to acknowledge the generous financial assistance given to the support of the Flora of the Carolinas Project by Mrs. W. C. Coker; by the Alumni Annual Giving Fund and the Smith Fund of the University of North Carolina; and the National Science Foundation in grant, G4450.

Alopecurus myosuroides Huds.—Cherokee Co.: edge of woodland, 5 mi. se. of Blacksburg on S. C. 5, *Bell 2198*; cultivated field, 3.2 mi. nnw. of jct. of S. C. 150 and U. S. 29 on S. C. 150 (n. of Gaffney), *Ahles 22722*.

Chase (1950) indicates Maine to North Carolina on the Atlantic coast on a map.

Cynosurus echinatus L.—Pickens Co.: Glassy Mt., 3 mi. ne. of Pickens, *Freeman 57363*. Spartanburg Co.: margin of Meadow Creek, ne. of Inman, *Bell 8364*.

Fernald (1950) does not give a range, while Chase (1950) lists only North Carolina and Maryland east of the Mississippi River.

Eragrostis curvula (Schrad.) Nees—Anderson Co.: roadside, 1.5 mi. sw. of Anderson on U. S. 29, *Ahles 13528*. Calhoun Co.: sandy roadside, 1.6 mi. nnw. of jct. Co. Rts. 29 & 33 on Co. Rt. 29 (sw. of St. Matthews), *Ahles 25635*. Laurens Co.: field margins by Co. Rt. 38, 6 mi. s. of Clinton, *Bell 7966*. Lexington Co.: roadside, 2.2 mi. w. of Cayce, *Radford 23309*; roadside, 4 mi. w. of Gilbert, *Radford 29884*. Orangeburg Co.: sandy roadside, 1.6 mi. sw. of jct. S. C. 394 & 3 on S. C. 394 (wsw. of town of North), *Ahles 25342*.

Chase (1950) says, "spontaneous in Florida, Texas, and Arizona."

Eragrostis hypnoides (Lam.) BSP.—Greenwood Co.: fresh-water marsh, Quarter Creek, near S. C. 72, 8 mi. ne. of Greenwood, *Radford 29026*.

Chase (1950) reports this species as occurring nearly throughout the United States but no record is shown from South Carolina on the distribution map.

Bulbostylis barbata (Rottb.) Clarke—Aiken Co.: sandy border of road, Aug. 1952, *W. T. Batson & W. R. Kelley* (USC). Allendale Co.: sandy field sw. of Burton on Co. Rt. 40, *Bell 4015*. Barnwell Co.: sandy field, Aug. 30, 1951, *W. R. Kelley & R. N. Tulloch* (USC). Chesterfield Co.: field 4 mi. se. of Jefferson, *Radford 18752*. Colleton Co.: roadside by U. S. 21, 0.6 mi. n. of jct. with Co. Rt. 63, *Bell 4550*. Greenwood Co.: ditch, Ninety Six Creek, 3.2 mi. ese. of Ninety Six, *Radford 26594*. Jasper Co.: disturbed sandy roadside, 3 mi. ne. of Coosawhatchie on U. S. 17, *Ahles 15684*. Lee Co.: field 4 mi. nne. of Lucknow, *Radford 27294*. Lexington Co.: alluvial meadow near U. S. 378 on Little Hollow Creek, 6 mi. n. of Gilbert, *Radford 27073*. Marlboro Co.: ditch, 5 mi. n. of Wallace near Whites Creek, *Radford 15590*. McCormick Co.: swamp forest, Savannah River near S. C. 28 se. of Clarks Hill, *Radford 26197*. Pickens Co.: field, Keowee River, near S. C. 183, w. of Pickens, *Radford 16410*. Sumter Co.: field 1 mi. w. of Scottsville near Black River, *Radford 29497*.

Small (1933) reports this (as *Stenophyllus bar-*

batus (Rottb.) Britton) from Florida to Alabama and South Carolina. Svenson (1957) gives the range as Georgia, Florida, and Alabama. Fox, Godfrey, and Blomquist (1952) have reported this species from North Carolina as *B. floridana* (Britton) Fern.

Bulbostylis warei (Torr.) Clarke—Jasper Co.: sandhill, 7.9 mi. nw. of Tillman, 3.2 mi. se. of railroad, *Ahles 18206*.

According to Small (1933) and Svenson (1957) this represents a northern range extension from Florida and Georgia into South Carolina. This is the same sand ridge from which we recorded *Dicerandra densiflora, Geobalanus oblongifolius* and *Rudbeckia mollis* last year.

Cyperus retrorsus Chapm. var. *deeringianus* (Britton & Small) Fernald & Griscom—Clarendon Co.: pineland-savannah, 3 mi. ene. of Turbeville, *Radford 28228*. Georgetown Co.: pineland-savannah, 5 mi. e. of North Santee, *Radford 28704*. Hampton Co.: flat pine woods, 0.8 mi. nw. of Brighton on Co. Rt. 20 and 0.8 mi. wsw. on dirt road, *Ahles 18243*. Marlboro Co.: bog, 1.5 mi. e. of Wallace near S. C. 90, *Radford 15627*.

Small (1933) treats this variety as *C. deeringianus* Britton & Small ranging from Florida to Mississippi and Georgia. Kukenthal (1936) in his world treatment of the genus, considers *C. deeringianus* as a variety of *C. retrorsus*. The Carolina material indicates a varietal status only. Kukenthal (1936) gives the range as Virginia, Georgia and Florida on the eastern seaboard.

Cyperus retrorsus Chapm. var. *robustus* (Boeck.) Kukenth.—Allendale Co.: sandy upland 2 mi. w. of Barton on Co. Rt. 23, *Bell 5098*.

Small (1933) cites this, (as *C. plankii* Britton) ranging from Mississippi to Texas and Oklahoma. Kukenthal (1936) considers this a variety of *C. retrorsus* found in Virginia, Alabama, Louisiana, Oklahoma and Texas.

Cyperus sesquiflorus (Torr.) Mattf. & Kukenth.—Beaufort Co.: brushy savannah, 3.5 mi. nw. of old Hilton Head Ferry Landing, *Bell 3808*. Charleston Co.: roadside ditch, 1.5 mi. s. of Rantowles on S. C. 162, *Ahles 32033*. Clarendon Co.: savannah, 2.3 mi. s. of St. Paul, *Radford 28027*; pineland savannah near U. S. 301, 3.5 mi. ne. of Turbeville, *Radford 28115*. Colleton Co.: roadside ditch by U. S. 21, 1.2 mi. s. of Orangeburg-Colleton Co. line, *Bell 4547*. Florence Co.: spring run and pond margin by U. S. 378 ne. of Lake City and 1 mi. w. of Lynches River, *Bell 10892*. Hampton Co.: pine-savannah, 3.1 mi. nw. of Yemassee on S. C. 28, *Ahles 15709*.

Small (1933) describes this as a species of *Kyllinga*, giving the distribution as Florida to Mississippi and Georgia. Kukenthal (1936) considers this entity as a species of *Cyperus* reported from Georgia, Florida, Mississippi and Louisiana.

Fimbristylis miliacea (L.) Vahl—Jasper Co.: pine-savannah, 1.8 mi. nw. of jct. U. S. 17-A and Co. Rt. 34 on Co. Rt. 34, *Ahles 18182*. Newberry Co.: near Whit's Motor Court, Newberry, *Freeman 56599*. Pickens Co.: bog, Twelve Mile Creek near U. S. 183 w. of Pickens, *Radford 16608*. Union Co.: margin of Broad River, Lockhart, *Freeman 56599*.

This native of India has been found on ballast in Pennsylvania. It has also been reported from Florida, Arkansas and California, according to Svenson (1957).

Scirpus koilolepis (Steud.) Gl.—Lexington Co.: field, 5 mi. n. of Leesville, *Radford 20551*. Saluda Co.: field near S. C. 391, 5 mi. n. of Batesburg, *Radford 20566*. York Co.: pasture 1.7 mi. nne. of jct. Co. Rt. 64 and S. C. 49 on Co. Rt. 64 (just n. of York), *Ahles 22933*.

Beetle (1947) states the range as Georgia, Tennessee and Alabama in the south. Ahles, Bell and Radford (1958), report it from North Carolina.

Camassia scilloides (Raf.) Cory—York Co.: wet woods, 1.5 mi. wnw. of jct. Co. Rt. 82 & S. C. 72 in Smiths, *Ahles 22970*.

The ranges as given by Fernald (1950), Small (1933) and Gleason (1952) might well include the western part of the Carolinas, but Gould (1942) maps this species and excludes South Carolina. Gould cites specimens from Floyd Co., Georgia, Smyth Co., Virginia, and numerous specimens from Tennessee adjacent to North Carolina.

Trillium lancifolium Raf.—Kershaw Co.: rich wooded floodplain, Wateree River just s. of Camden, *H. J. Oosting 310* (DUKE). McCormick Co.: mixed deciduous forest, Stevens Creek, 1.5 mi. ne. of Clarks Hill, *Radford 31703*; *31753*.

S. J. Smith noted on the herbarium sheet that Oosting's collection was the first for South Carolina. No published record has been found to that effect, so the Kershaw and McCormick specimens are cited as the first records from South Carolina.

Dioscorea batatas Dcne.—Lexington Co.: alluvial forest, Horse Creek, 4.5 mi. n. of Summit, *Radford 29885*. Spartanburg Co.: wet shrubby place on flats, Motlow Creek near Campobello, *E. H. Walker 3503* (DUKE).

Alexander (1940) reported the first specimen of this native of China in the United States from

North Carolina. Gleason (1952) states that it often escapes in the south and is occasionally in the manual range.

Belamcanda chinensis (L.) DC.—Lancaster Co.: woodland border, 4.8 mi. sw. of Heath Springs on S. C. 522, *Ahles 31280*; thickets, 2.1 mi. n. of Kershaw-Lancaster Co. line on S. C. 97 and 1.9 mi. e. on dirt road (sw. corner of Co.), *Ahles 34813*.

Although South Carolina is included in the general ranges, no specimen has been cited or reference made for that state.

Sisyrinchium albidum Raf.—McCormick Co.: oak-hickory forest, Stevens Creek, 1.5 mi. ne. of Clarks Hill, *Radford 31742*.

Small (1933) gives the range of this species as Alabama to Louisiana, Missouri, Michigan and North Carolina, which indicates that it might be in South Carolina.

Eulophia ecristata (Fern.) Ames—Clarendon Co.: savannah, near U. S. 301, 3.5 mi. ne. of Turbeville, *Radford 28092*; savannah, 5.7 mi. se. of Manning, *Radford 28244*. Dillon Co.: flat pine-oak woods, 1.1 mi. ssw. of Bingham (1.7 mi. nne. of Co. line), *Ahles 37150*.

Small (1933) gives the range as "pen. Fla." and Correll (1950), as "North Carolina, Louisiana, Florida; also Cuba."

Quercus georgiana M. A. Curtis—Kershaw Co.: granite outcrop, Flat Rock, *Radford 27713*; *30001*.

Small (1933) reports this species from the Piedmont of Georgia and Alabama. The Kershaw County locality is a northeastward range extension into the fall zone of South Carolina.

Urtica chamaedryoides Pursh—McCormick Co.: mixed deciduous forest, Stevens Creek, 1.5 mi. ne. of Clarks Hill, *Radford 22444*.

According to Small (1933), Fernald (1950), and Gleason (1952), this is an Appalachian species, and occurs from Florida to Texas and northward to West Virginia.

Humulus japonicus Sieb. & Zucc.—Abbeville Co.: alluvial woods, near Norris Creek, 1 mi. ese. of Abbeville, *Radford 25918*; fresh-water marsh, Norris Creek, 1.8 mi. ese. of Abbeville, *Radford 30908*. York Co.: road embankment, Sugar Creek on S. C. 160, e. of Fort Mill, *Ahles 34666 & 34666A*; waste ground, Rock Hill, *Ahles 27158*.

Small (1933) does not include this species. Fernald (1950) gives, "N. E. to Mich., s. to Va. and Mo." Gleason (1952) says, "New England to Mo." Freeman (1955) reports this species for North Carolina.

Mirabilis jalapa L.—Cherokee Co.: well established perennials on road embankment, Cherokee Falls, *Ahles 31065*.

This species, perennial in this part of the country, is able to become very well established and persists for a very long time.

Silene armeria L.—Horry Co.: sandy turkey oak woods w. of U. S. 17 at northern edge of Myrtle Beach, *Bell 7675*.

Fernald (1950) gives the range as far south as Virginia. Freeman (1955) records it for North Carolina.

Silene dichotoma Ehrh.—Georgetown Co.: field, Black River, 0.5 mi. se. of Browns Ferry, *Radford 21541*.

This species is reported from various places in the United States by Small (1933), Fernald (1950) and Gleason (1952). The absence of specimens in NCU, DUKE and NCSC is the principal reason for including the species as a record new to South Carolina.

Nelumbo nucifera Gaertn.—Lee Co.: fresh-water marsh near U. S. 154, 4 mi. s. of Charles, *Radford 27230*.

This introduction is not included in Small (1933). The plant was well established at an old pond site in Lee County.

Isopyrum biternatum (Raf.) T. & G.—McCormick Co.: mixed deciduous forest near Stevens Creek, 1.5 mi. ne. of Clarks Hill, *Radford 30526*, *31707*.

Small (1933), Fernald (1950) and Gleason (1952) report the range of this species as west of the Appalachians to northwestern Florida. Fox, Godfrey and Blomquist (1950), reported it from North Carolina.

Ranunculus arvensis L.—Greenwood Co.: field, near S. C. 34, 2.5 mi. w. of town of Ninety Six, *Radford 20105*.

Benson (1948) gives the range as several western states, New York, New Jersey and Georgia in the east. Gleason (1952) states that the plant is occasionally introduced along the Atlantic Coast. Ahles, Bell and Radford (1958), report *R. arvensis* var. *tuberculatus* from North Carolina.

Ranunculus muricatus L.—Berkeley Co.: lawn weed, Stony Landing Plantation on West Branch Cooper River (e. of Moncks Corner), *Ahles 22445*; sandy lot, 0.5 mi. s. of jct. U. S. 17-A and U. S. 52 on U. S. 52, *Ahles 22466*. Edgefield Co.: mixed deciduous forest, Stevens Creek, 1.5 mi. e. of Modoc, *Radford 20327*. Greenwood Co.: very abundant in waste places near Park Seed Company in Greenwood, *Freeman 5783*. McCormick Co.: ditch, Parksville, *Radford 22287*. York Co.:

pasture, 0.8 mi. nw. of jct. of Co. Rt. 721 and S. C. 901 on Co. Rt. 271 (s. of Rock Hill), *Ahles 22974*.

Benson (1948) reports the range of this species in the United States essentially as west coast, then Arkansas and southeastern Texas to South Carolina. No herbarium specimens from South Carolina are cited. Walter (1788) does report the species from around Charleston, South Carolina. No specimens of this species are in NCU, DUKE or NSCS. Since there is some doubt as to the existence of an herbarium specimen from South Carolina, we are including citations from five counties.

Thlaspi arvense L.—Marlboro Co.: waste place, McColl, *Radford 9268*.

Fernald (1950) states the range as south beyond the limits of that manual. Gleason (1952) has the range from Newfoundland to Florida on the eastern seaboard. Small (1933), however, gives a different range, "N. C. to Ark., Kans., Man., and Que." It is due to the range given by Small that the South Carolina collection seems worthy of recording along with the fact that out of the numerous collections made in South Carolina, this was the only specimen found.

Dicentra cucullaria (L.) Bernh.—McCormick Co.: mixed deciduous forest, Stevens Creek, 1.5 mi. ne. of Clarks Hill, *Radford 31699*.

According to Small (1933) and Fernald (1950), this represents a southeastward range extension from northern Georgia and North Carolina into central South Carolina.

Sarracenia x rehderi Bell—Colleton Co.: pine savannah, 0.7 mi. se. of Hiotts, *Ahles 12218*; *Bell 2359*.

Previously known only from the type locality in North Carolina according to Bell (1952). In 1956 specimens were collected, but they were sterile. Plants, however, brought in at that time, were grown in the University of North Carolina greenhouse and flowered April, 1958, making the identification positive.

Ribes echinellum (Coville) Rehder—McCormick Co.: mixed deciduous forest, Stevens Creek, 1.5 mi. ne. of Clarks Hills, *Radford 22456*; *31713*.

Small (1933) reports this as *Grossularia echinella* Coville from Lake Miccosukee, Florida. The Stevens Creek plant fits the species description in every detail, including the unusual time of leafing. This species forms a thorny mat for at least 200 yards in a mixed deciduous community on the south side of the creek. From the literature, this seems to be the second station for the species.

Sanguisorba annua Nutt.—Edgefield Co.: roadside, 5.5 mi. nw. of Johnston, *Radford 22575*.

Gleason (1952) states the range as Arkansas and Texas, adventive in Massachusetts. Small (1933) does not include the species in the southeastern flora. The species was well established on a road bank and along the edge of a field in Edgefield County.

Amorpha cynostachya M. A. Curtis—Florence Co.: lowland of Lynches River ne. of Lake City, *Bell 6124*; swamp forest and old sand pit just off Co. Rt. 46, 3.9 mi. e. of Cowards, *Bell 10845*; sandy banks of Lynches River s. of Johnson's Crossroads, *Bell 7592*.

Small (1933) for the range says, "Fla. to Okla., N. D., and Ky., in the Coastal Plain of Ga."

Amphicarpa bracteata (L.) Fern. var. *comosa* (L.) Fern.—Anderson Co.: swamp forest, Rocky Creek near S. C. 80, nw. of Anderson, *Radford 18033*. Pickens Co.: ditch, 1 mi. n. of Rocky Bottom near U. S. 178, *Radford 16835*.

Because of the scarcity of collections and lack of a previously published record, this variety is considered new for South Carolina. The range as given in manuals only serves to confuse rather than clarify the issue. Fernald (1950) says, "Me. to N. D., s. to Va., Tenn. and Tex.", a range that would definitely place this entity as new to the state. Gleason (1952) says, "range of the species but more abundant westward." The range given by him for the species is, "Que. and N. S. to Man. and Mont., s. to Fla. and Tex." Small (1933) under *Falcata pitcheri* says, "described from Ark. . . . may occur east of the Mississippi River."

Crotalaria incana L.—Georgetown Co.: waste place on Sampit River near Georgetown, *Radford 28573*.

Small (1933) gives the range as, "pen. Fla. and the Keys. Nat. of tropics." Senn (1939) cites specimens only from Florida, Alabama and Texas. In South Carolina it is undoubtedly a waif and probably not persistent.

Daubentonia punicea (Cav.) DC.—Berkeley Co.: wooded streambank, 0.1 mi. s. of jct. Co. Rt. 16 and U. S. 176 on Co. Rt. 16 (sw. of Moncks Corner), *Ahles 26437*. Colleton Co.: low woodland, 0.2 mi. e. of jct. with U. S. 15, on Co. Rt. 34, *Bell 3658*. Dorchester Co.: roadside, Reevesville on U. S. 78, *Ahles 26289*. Florence Co.: roadside near Hebron Church (which is 5 mi. e. of Cowards), *Bell 7578*; low roadside just se. of

Byrds Crossroads, *Bell 7611*. Hampton Co.: low woodland, 0.3 mi. ne. of jct. Co. Rt. 140 and S. C. 28 on Co. Rt. 140, *Ahles 15756*. Horry Co.: sandy fallow field, S. C. 90, 2.8 mi. s. of jct. with U. S. 17, *J. A. Duke 0081*; roadside, Stephens Crossroads (which is w. of Cherry Grove Beach), *Bell 7723*. Jasper Co.: waste ground, jct. of Co. Rt. 34 and U. S. 17 on Co. Rt. 34, s. of Hardeeville, *Ahles 15803*. Lexington Co.: waste place, 5 mi. s. of Cayce, *Radford 23383*. Sumter Co.: roadside, Brogdon, *Radford 23943*; waste place, Sumter, *Radford 27568*.

This native of tropical America has become very well established in the coastal counties of South Carolina. Small (1933) gives as the range, "Fla. to La."

Desmanthus illinoensis (Michx.) MacM.—Aiken Co.: waste place near Savannah River on U. S. 1, *Radford 525*. Chester Co.: cut-over pineland to n. of S. C. 72, 1.1 mi. e. of Broad River (sw. of Chester) *Bell 10037*. Edgefield Co.: railroad, Edgefield, *Radford 26549*. Greenwood Co.: railroad, Greenwood, *Radford 26745*.

The range as given in the manuals clearly places this species west of South Carolina. The species is apparently introduced and is fairly common where found.

Desmodium tortuosum (Sw.) DC.—Allendale Co.: railroad, Barton, *Bell 5229*; swamp and sandy upland about 2 mi. w. of Barton on Co. Rt. 23, *Bell 5096*. Clarendon Co.: pineland-savannah, near U. S. 301, 3.5 mi. ne. of Turbeville, *Radford 28045*; roadside, 3 mi. ene. of Turbeville, *Radford 28226*; oak-hickory forest, 6.5 mi. se. of Bloomville, *Radford 31067*. Colleton Co.: cultivated field, 0.5 mi. sw. of Ritter on Co. Rt. 41, *Ahles 15486*; cultivated field and roadside ditch by U. S. Rt. 21, 0.5 mi. s. of jct. with Co. Rt. 63, *Bell 4557*; by pond in low pineland, 2.2 mi. n. of Canadys on S. C. 61, *Bell 4608*. Florence Co.: roadside by swamp forest of Lynches Lake at n. edge of Lake City, *Bell 10873*. Georgetown Co.: maritime forest, 1 mi. ne. of Waverly Mills, *Radford 31296*; maritime forest, Retreat Beach, *Radford 31331*. Jasper Co.: waste ground, Ridgeland, *Ahles 15603*. Lexington Co.: waste place, Gaston, *Radford 29834*. Marion Co.: roadside, fencerows and fields at Gresham, *Bell 11088*. Sumter Co.: mixed deciduous forest, 1 mi. w. of Scottsville, near Black River, *Radford 29546*; waste place, Sumter, *Radford 29606*; roadside, 2 mi. s. of Statesburg, *Freeman 56803*.

This species, unlike most in this genus, is extremely weedy, frequently invading fields. It appears very much like an annual. South Carolina is an extension of the range northward. Small (1933) under *Meibomia purpurea* (Mill.) Vail. gives the range as, "Fla. and Ga."

Galactia elliottii Nutt.—Beaufort Co.: roadside of S. C. Rt. 170, 1.7 mi. s. of jct. with Co. 18, *Bell 3799*; climbing on thickets, pine savannah, 1.7 mi. s. of jct. S. C. 170 & Co. Rt. 18 on S. C. 170, e. side of road, *Ahles 20953*. Jasper Co.: pine savannah, 1.7 mi. s. of jct. S. C. 170 and Co. Rt. 18 on S. C. 170 (w. side of road), *Ahles 15661*.

Although fairly exhaustive collecting was done in South Carolina during 1956–57, only the two localities cited were found. These actually represent only one station situated on the county line. This is included here as new to South Carolina because of the lack of a published record and its scarcity. The range as given by Small (1933) would include this state.

Lathyrus hirsutus L.—Abbeville Co.: field, Cane Creek, 4 mi. se. of Abbeville, *Radford 26003*; roadside, near S. C. 81, 3 mi. s. of Calhoun Falls, *Radford 22692*. Berkeley Co.: railroad right-of-way, Moncks Corner, *Ahles 26589*. Edgefield Co.: roadside, 3 mi. w. of Cleora, *Radford 22628*.

This species, a native of Europe, is very local and still apparently very scarce in South Carolina. The range as given by Small (1933) is, "N. Miss.", by Fernald (1950), "Va. to Ala. and Miss.", while Gleason (1952) says, "se. Va."

Lespedeza bicolor Turcz.—Allendale Co.: low woods by sandy field, 0.4 mi. e. of Barton on Co. Rt. 20, *Bell 5091*. Colleton Co.: sandy oak-pine woods, 0.7 mi. e. of jct. Co. 28 & U. S. 21 on Co. 28, *Ahles 17910*. Edgefield Co.: roadside 3 mi. ne. of Trenton, *Radford 30293*. Fairfield Co.: woodland margin by Co. Rt. 92, s. of Winnsboro, *Bell 9445*. Lee Co.: oak-hickory forest, 1.3 mi. ene. of St. Charles, *Radford 27226*. Newberry Co.: roadsides and waste places, Newberry, *Bell 9134*. Spartanburg Co.: margins of Little Fergerson Creek, 5.2 mi. se. of Moore on Co. Rt. 86, *Bell 10472*; pools and sandy pockets below Rainbow Lake Dam n. of Spartanburg, *Bell 8341*. Williamsburg Co.: oak-hickory forest, near Hollimans Swamp, 1.8 mi. ne. of Greeleyville, *Radford 31152*.

Small (1933) says, "Fla. to N. C.", and Fernald (1950) and Gleason (1952) do not include it within their ranges. No previous reports for South Carolina could be found.

Lespedeza stipulacea Maxim.—Edgefield Co.: pasture, 2 mi. nne. of Morgana, *Radford 26505*

Greenwood Co.: roadside, near Hard Labor Creek, 2.6 mi. se. of Bradley, *Radford 26768*.

This species, very similar to *L. striata* (Thunb). H. & A., has the same tendency to spread from cultivation and become a very aggressive weed. The lack of published reports for South Carolina is the only reason for its inclusion as new to the state.

Lespedeza thunbergii (DC.) Nakai—Marion Co.: under oaks and pines in sandy cemetery at crossroads 3.4 mi. s. of Britton Neck, *Bell 10936*.

This native of eastern Asia has been introduced for ornamental purposes. Fernald (1950) says, "Mass. and southw.", a range that has such a large scope that it is impossible to interpret.

Psoralea psoralioides (Walt.) Cory var. *eglandulosa* (Ell.) Freeman—Abbeville Co.: oak-hickory forest, near S. C. 71, 6 mi. e. of Lowndesville, *Radford 22786*. Anderson Co.: wooded roadside, near jct. of Beaverdam Creek and Tugaloo River, *Ahles 13477*. Oconee Co.: border of upland pine-oak woods, 0.3 mi. sw. of Little River on S. C. 11 (old S. C. 288), *Ahles 13944*.

Psoralea psoralioides (Walt.) Cory is very abundant in South Carolina, but the variety *eglandulosa* (Ell.) Freeman is restricted to the extreme northwestern corner of that state. The ranges as given by Fernald (1950) and Gleason (1952) could be interpreted to include South Carolina, however the lack of specimens in NCU, DUKE and NCSC plus no previously published report for that state warrant its inclusion here.

Thermopsis fraxinifolia (Nutt.) M. A. Curtis—Abbeville Co.: alluvial woods, near Savannah River, 3 mi. sw. of Calhoun Falls, *Radford 22768*. Pickens Co.: roadside and upland woods 0.8 mi. from U. S. 178, along the Sassafras Mountain Road, *Bell 3341*.

Small (1933) says, "Ala. to Tenn. and N. C." Larisey (1940) says, "Distribution: North Carolina to Georgia and Tennessee." Under the citation of specimens, however, she cites specimens only from North Carolina and Tennessee.

Vicia tetrasperma (L.) Moench.—Barnwell Co.: waste place, Williston Railroad Yards, *Radford 9208*. Chester Co.: flood plain of Broad River, ½ mi. se. of Lockhart, *Freeman 5635*. Florence Co.: low railroad right-of-way at radio tower, 1 mi. nw. of Florence, *Bell 6036*.

The range of this species as given by Fernald (1950) and Gleason (1952) includes South Carolina, but the absence of a published report for that state plus the fact that the range as given by Small (1933) only goes as far south as North Carolina seems to warrant reporting it here.

Euphorbia commutata Engelm.—Fairfield Co.: ¾ mi. ne. of Blairs in low open woods, *Freeman 5671*. McCormick Co.: mixed deciduous forest, Stevens Creek, 1.5 mi. ne. of Clarks Hill, *Radford 31728*.

This species seems to be an Appalachian and mid-western plant according to Small (1933), Fernald (1950), and Gleason (1952). No specimens are present at NCU, DUKE or NCSC.

Callitriche terrestris Raf.—Spartanburg Co: low meadow, 3 mi. e. of Campobello, *Freeman 57149*. Sumter Co.: swamp forest near Wateree River nw. of Horatio, *Radford 20961*.

South Carolina is well within the reported range of this species but Fassett (1951) does not record any specimens from the state.

Ammi majus L.—Horry Co.: dry sandy roadside at Intracoastal Waterway Bridge of Myrtle Beach, *Bell 7790*.

Mathias and Constance (1944–45) give the range of this European introduction as Newfoundland and Pennsylvania only on the east coast. Neither Fernald (1950) nor Gleason (1952) include this species. Small (1933) gives the range as Alabama to Texas in the south.

Scandix pecten-veneris L.—Lancaster Co.: roadside ditch and pecan orchard, 1.4 mi. wnw. of Cane Creek on S. C. 9 (about 2 mi. w. of Lancaster), *Ahles 23052*. Spartanburg Co.: fallow field, 2.1 mi. w. of Pacolet, *Bell 5737*.

The ranges given for this species may very well include South Carolina, but the lack of specimens and actual cited reports from South Carolina warrant its inclusion as new.

Spermolepis echinata (Nutt.) Heller—Edgefield Co.: waste place near Shaver Creek, 9 mi. ssw. of Trenton, *Radford 22524*.

Small (1933), Fernald (1950), Gleason (1952) and Mathias and Constance (1944–45) give the range as essentially western.

Torilis japonica (Houtt.) DC.—Union Co.: fields by little used railroad spur near hwy., in Carlisle, *Bell 8470*. York Co.: barnyard and roadside, 2.2 mi. nw. of jct. S. C. 907 & 49 on S. C. 907, (sw. of Sharon), *Ahles 27154*.

Included here as new to South Carolina, although the range given by Fernald (1950) would include that state and the range given by Gleason (1952) might include it, the range as given by Mathias and Constance (1944–45) "New York to Virginia, west to Missouri, Oklahoma, and Texas", definitely excludes it. At the York

County locality it was quite abundant and the plants were very robust, attaining heights of three feet.

Trepocarpus aethusae Nutt.—McCormick Co.: swamp forest, Savannah River near S. C. 28, se of Clarks Hill, *Radford 26195*.

Mathias and Constance (1944–45) report the range as Mississippi and Alabama to Arkansas and Texas. This species was very abundant.

Dodecatheon meadia L.—Abbeville Co.: mixed deciduous forest, Savannah River, 3.5 mi. s. of Calhoun Falls, *Radford 20042*. Edgefield Co.: mixed deciduous forest, Stevens Creek, 1.5 mi. e. of Modoc, *Radford 20302*. Richland Co.: Columbia, *P. J. Philson*, April 11, 1936 (USC).

Fassett (1944) in his treatment of *Dodecatheon* gives the range to North Carolina and Georgia but does not cite any specimens or show any records of this species from South Carolina.

Sabatia bartramii Wilbur—Hampton Co.: savannah along railroad, 0.2 mi. n. of Luray on U. S. 321, *Bell 3952*.

Wilbur (1955) describes this species and gives the range as Mississippi, Alabama, Florida, and Georgia.

Nemophila microcalyx (Nutt.) Fisch. & Mey.—Laurens Co.: low bottoms of Cane Creek 2 mi. from Cross Hill, *Bell 5560*. Kershaw Co.: alluvial woods, Wateree River, 2.5 mi. s. of Camden, *Radford 20804*. Edgefield Co.: alluvial woods, Shaver Creek, 2.5 mi. n. of Morgana, *Radford 20299*. McCormick Co.: alluvial woods, Stevens Creek, e. of Modoc, *Radford 20222*.

South Carolina is within the range of this species, but the exclusion of it from that state by Constance (1941) warrants its inclusion here.

Verbena halei Small—Sumter Co.: waste place, Wedgefield, *Radford 20975*.

Not recorded previously from the Atlantic coast states, it is a native of the Gulf states and is apparently adventive elsewhere.

Lithospermum tuberosum Rugel—McCormick Co.: oak-hickory forest, Stevens Creek, 1.5 mi. ne. of Clarks Hill, *Radford 31751*.

On the basis of the distribution data given by Small (1933), Fernald (1950), and Gleason (1952), this is the first record east of the Appalachians.

Myosotis macrosperma Engelm.—Chester Co.: low woodland below Fishing Creek Pond Dam, *Bell 7445*.

On a map, Fernald (1941) shows this species in eastern United States but not in South Carolina.

Monarda citriodora Cerv.—Edgefield Co.: pasture, 2 mi. nne. of Morgana, *Radford 26501*.

Small (1933) under the name *Monarda dispersa* Small, gives the range as "Fla. to Tex,. N. M., Mo., and Ga.". McClintock and Epling (1942) give a much clearer picture of the distribution, pointing out that it is native west of the Mississippi and introduced in Alabama, Georgia, Illinois, Louisiana, Mississippi, and Tennessee. In South Carolina it is undoubtedly introduced, but fairly abundant at the cited locality.

Monarda clinopodia L.—Oconee Co.: mixed deciduous forest, 7 mi. w. of Salem, *Radford 17748*. Pickens Co.: jct. of S. C. 288 & Co. Rt. S-39-47, *Freeman 57427*; by stream, north side of Table Rock, *L. Rodgers 380*, (DUKE).

The range as given by Small (1933) could be interpreted to include South Carolina, however, the concise range, "Conn. to O. and Ill., s. to N. C. and Ala." as given by Gleason (1952) definitely excludes that state. McClintock & Epling (1942) exclude South Carolina, Georgia and Florida.

Amphianthus pusillus Torr.—Lancaster Co.: granite outcrop, Forty Acre Rock, about 9 mi. n. of Kershaw, *Ahles 23100*.

Small (1933) says, "Piedmont, Ga." Pennell (1935), "Georgia. De Kalb: Stone Mt., Canby. Rockdale: . . . , Leavenworth." McVaugh (1943) lists localities only from Georgia for this species. In South Carolina it occurs in the vernal pools on the granite outcrop. Although there are numerous such pools, it is to be found in only two and these side by side. In both pools it is very abundant, practically covering the entire surface with its floating leaves.

Dasystema macrophylla (Nutt.) Raf.—York Co.: swampy woods, about 2 mi. wnw. of Smiths on Co. Rt. 82, *Ahles 31158*.

Pennell (1935) cites northwestern Georgia as the only locality in the states on the Atlantic seaboard. The ranges as given by the manuals would also seem to indicate this.

Plantago purshii R. & S.—Lancaster Co.: roadside 0.1 mi. ne. of jct. U. S. 521 and Co. Rt. 161 on Co. Rt. 161, just north of jct. U. S. 521 and S. C. 75 (nw. corner of county), *Ahles 27237*.

In addition to the native range, Fernald (1950) states, "casual e. to N. E. and N. J." This report represents the first for southeastern United States.

Lobelia georgiana McVaugh—Marlboro Co.: bog, 2 mi. e. of Wallace near S. C. 9, *Radford 19041*.

The ranges as given by the manuals of this area

would include South Carolina, but since McVaugh (1936) excludes it from that state on his distribution map, it is here considered new to that state.

Bidens connata Muhl.—Greenwood Co.: freshwater marsh, Quarter Creek, near S. C. 72, 8 mi. ne. of Greenwood, *Radford 29022*.

Wiegand (1933) gives the range as far south as North Carolina. Fernald (1950) and Sherff (1937) list numerous varieties, none of which are given farther south than Virginia. Cronquist (1952) under the name *Bidens tripartita* L. includes several species, therefore, it is not possible to delineate the range of *Bidens connata*.

Centaurea maculosa Lam.—Greenwood Co.: roadside, Coronaca Creek, near U. S. 221, 5 mi. ne. of Greenwood, *Radford 26644*.

Small (1933) does not include this species. Fernald (1950) gives the range south to Virginia. Cronquist (1952) does not give a range. Recorded for North Carolina by Godfrey (1950).

Chrysanthemum lacustre Brot.—Abbeville Co.: field near S. C. 185, 5 mi. se. of town of Due West, *Radford 26046*.

Ahles, Bell and Radford (1958) recorded this species from North Carolina and Michigan. It had not previously been reported for the United States.

Coreopsis pubescens Ell. var. *robusta* Gray—Pickens Co.: Glassy Mt., 3 mi. ne. of Pickens, *Freeman 57856*.

Boynton (1933) does not include this variety, Fernald (1950), gives "Va. and N. C. to Ky." Cronquist (1952) repeats this same range. Ives (1944) records *Coreopsis pubescens* for South Carolina, but the variety seems previously unrecorded.

Lactuca saligna L.—York Co.: cultivated field, about 2 mi. wnw. of Smiths on N. C. 82, *Ahles 31160*.

Fernald (1950) gives the range as south to Virginia. Cronquist (1952) gives the eastern limit of range as Ohio and West Virginia. Radford (1948) reported this species for North Carolina.

Solidago notabilis Mackenzie—McCormick Co.: mixed deciduous forest near S. C. 28, 5 mi. se. of Clarks Hill, *Radford 30576*; mixed deciduous forest, Stevens Creek, 1.5 mi. ne. of Clarks Hill, *Radford 42671*.

Mackenzie (1933) indicates a range mostly west of the Alleghenies, "Fla. to Tex., Ark., and Tenn." South Carolina is a northward extension of range at least in the Atlantic states. Torrey & Gray (1840 (3)) applied the name *Solidago amplexicaulis* to this species on the basis of the appropriateness of the name, without having seen the original description. Mackenzie (1933) renamed the plant *S. notabilis* on the basis that Torrey & Gray misapplied the name *S. amplexicaulis* Martens. Since the name *S. amplexicaulis* Martens is treated as a synonym of *S. riddellii* in Index Kewensis, the name *S. notabilis* is here applied for this species. At the Clarks Hill locality this species was a dominant, herbaceous plant, but at the other locality it was scarce.

Solidago rigida L.—Fairfield Co.: road embankment along U. S. 21, 3.1 mi. n. of Ridgeway, *Bell 9956*.

Mackenzie (1933) says, under *Oligoneuron grandiflorus* (Raf.) Small, "Ga. to Tex., Man., and Md. and extending e. to Mass." Fernald (1950) says, "Mass, to Sask., s. to Ga., La. and Tex." Cronquist (1952) lists three varieties for which he gives the following ranges: var. *rigida*, "Minn., Mo., and Tex. eastward", var. *humilis* Porter, "Minn. and Ia. westward", and var. *glabrata* Braun, "Southern O. to Ga. and Tex." All of these ranges with the exception of Cronquist (1952) var. *humilis* could include South Carolina. Since they are all ambiguous and since we have been able to find only one locality for it in South Carolina, it is here included as new to that state.

LITERATURE CITED

AHLES, H. E., C. RITCHIE BELL, AND A. E. RADFORD. 1958. Species new to the flora of North or South Carolina. Rhodora **60:** 10–32.

ALEXANDER, E. J. 1940. Southern plant notes. Castanea **5:** 91–93.

BELL, C. RITCHIE. 1952. Natural hybrids in the genus *Sarracenia*, I. History, distribution and taxonomy. Jour. Elisha Mitchell Sci. Soc. **68:** 55–80.

BEETLE, A. A. 1947. *Scirpus*, in North American Flora **18:** 479–504.

BENSON, LYMAN. 1948. A treatise on North American Ranunculi. Am. Midl. Nat. **40:** 1–261.

BOYNTON, C. L. 1933. *Coreopsis*, in J. K. Small, Manual of the Southeastern Flora, pp. 1446–1450.

CHASE, AGNES. 1950. Manual of the Grasses of the United States, 1051 pp., United States Govt. Printing Office, Washington, D. C.

CONSTANCE, LINCOLN. 1941. The genus *Nemophila* Nutt. Univ. of Calif. Publ. Bot. **19:** 341–398.

CORRELL, DONOVAN S. 1950. Native orchids of North America north of Mexico. p. 399.

CRONQUIST, A. J. 1952. Compositae in H. A.

Gleason, Illustrated Flora of Northeastern United States. **3:** 323–545.

FASSETT, NORMAN C. 1944. *Dodecatheon* in eastern North America. Am. Midl. Nat. **31:** 455–486.

———. 1951. *Callitriche* in the New World. Rhodora **53:** 137–155, 161–182, 185–194, 209–222.

FERNALD, M. L. 1941. Another century of additions to the Flora of Virginia. Rhodora **43:** 485–553, 559–630, 635–657.

———. 1950. Gray's Manual of Botany, ed. 8, 1632 pp., American Book Co., N. Y.

FOX, W. B., R. K. GODFREY AND H. L. BLOMQUIST. 1950. Notes on distribution of North Carolina plants II. Rhodora **52:** 253–271.

———. 1952. Notes on distribution of North Carolina plants III. Rhodora **54:** 165–182.

FREEMAN, OLIVER M. 1955. Notes on the flora of Polk County, North Carolina. Castanea **20:** 37–57.

GLEASON, H. A. 1952. Illustrated Flora of Northeastern United States. 3 vols. New York Botanical Garden, N. Y.

GODFREY, R. K. 1950. Studies in the Compositae of North Carolina III. An enumeration of noteworthy distribution records. Jour. Elisha Mitchell Sci. Soc. **66:** 186–194.

GOULD, F. W. 1942. A systematic treatment of the genus *Camassia*. Am. Midl. Nat. **28:** 712–742.

HITCHCOCK, A. S. 1933. Poaceae, in J. K. Small, Manual of the Southeastern Flora, pp. 30–139.

IVES, S. A. 1944. The vascular plants of Greenville County, South Carolina. Bull. Furman Univ. **27:** 5–28.

KUKENTHAL, G. 1936. Cyperaceae-Scirpoideae-Cypereae, in Das Pflanzenr. **20:** 1–671.

LARISEY, MARY MAXINE. 1940. A revision of the North American species of the genus *Thermopsis*. Ann. Mo. Bot. Gard. **27:** 245–258.

MACKENZIE, K. K. 1933. *Solidago*, in J. K. Small, Manual of the Southeastern Flora, pp. 1344–1360.

MATHIAS, MILDRED and LINCOLN CONSTANCE. 1944–45. Umbelliferae, in North American Flora 28B 43–295.

MCCLINTOCK AND EPLING. 1942. A review of the genus *Monarda* (Labiatae). Univ. of Calif. Publ. Bot. **20:** 147–194.

MCVAUGH, ROGERS. 1936. Studies in the taxonomy of the eastern North American species of *Lobelia*. Rhodora **38:** 243–263; 276–298; 305–329; 346–362.

———. 1943. The vegetation of the granitic flat-rocks of the Southeastern United States. Ecol. Monogr. **13:** 121–166.

PENNELL, F. W. 1935. The Scrophulariaceae of eastern temperate North America. Acad. Nat. Sci. Philadelphia Monograph **1:** 1–650.

RADFORD, ALBERT E. 1948. The vascular flora of the olivine deposits of North Carolina. Jour. Elisha Mitchell Sci. Soc. **64:** 45–106.

SENN, H. A. 1939. The North American species of *Crotalaria*. Rhodora **41:** 317–367.

SHERFF, E. E. 1937. The genus *Bidens*, Part I Publ. Field Mus. Nat. Hist. Bot. Ser. **16:** 1–709.

SVENSON, H. K. 1957. Scirpeae, in North American Flora **18:** 505–556. Part 9.

TORREY, JOHN AND ASA GRAY. 1840 (43). A flora of North America **2:** pp. 504.

WALTER, THOMAS. 1788. Flora Caroliniana, 263 pp. London.

WIEGAND, K. M. 1933. *Bidens*, in J. K. Small, Manual of the Southeastern Flora, pp. 1450–1454.

WILBUR, R. L. 1955. A revision of the North American genus *Sabatia* (Gentianaceae). Rhodora **57:** 78–104.

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Germantown, Philadelphia, Pennsylvania

The unusually strong interest in botany[1] displayed by Thomas Jefferson, third president of the United States, is well known. Evidences are legion.

"The greatest service which can be rendered any country is to add an useful plant to its culture." ("The Writings of Thomas Jefferson," Vol. 1, p. 259 Andrew Lipscomb, editor.)

"Botany I rank with the most important sciences, whether we consider it's subject as furnishing the principle subsistence of life to man and beast, delicious varieties for our tables, refreshments for our orchards, the adornments of our flower borders, shade and perfume for our groves, materials for our buildings, medicaments for our bodies. to the gentleman it is certainly more interesting than Mineralogy (which I by no means undervalue) and is more at hand for his amusement. and to a country family it constitutes a great portion of their social entertainment. no gentleman should be without what amuses every step he takes into his fields." (Letter from Jefferson to Thomas Cooper. October 7, 1814)

"Botany is the school for patience, and it's amateurs learn resignation from daily disappointments." (Letter from Jefferson to Madame de Tesse, April 25, 1785)

"Mathematics, Natural Philosophy, Natural History, Anatomy, Chemistry, Botany will become amusements for your hours of relaxation and auxiliaries to your principal studies. Precious and delightful ones they will be." (Letter from Jefferson to T. M. Randolph, July 6, 1787).

"There are other branches of Science, however, worth the attention of every man: Astronomy, botany . . ." etc. (Letter from Jefferson to William Munford, June 18, 1799)

Botany seemed to be ever present in Jefferson's mind. As early as January 18, 1800, in a letter to Priestley, requesting suggestions on courses of study for the college which he was planning at Charlottesville, he writes ". . . I will venture even to sketch the sciences which seem useful and practicable for us, as they occur to me while holding my pen. Botany . . . etc." Priestley's reply showed that he was in agreement.

Jefferson was interested in botany for more than one reason. He thought that it was one of the sciences "worth the attention of every man . . . . not to be a proficient but to possess their general principles and outlines" so that we could "amuse and inform ourselves . . . as we proceed through life," holding such knowledge was "necessary for our character as well as our comfort" (Letter to William Greene Munford, June 18, 1799). Another reason was for Jefferson the usual, compelling one of utility, i.e. as an aid in agriculture, medicine, the industrial arts, and so forth (hence the large number of botany books in his library). His interest did not take him into theoretical speculation to any great depths, and although his library was particularly rich in scientific books, showing that his interests were wide and his knowledge deep (his major library containing eight hundred individual science titles), he was ever on the alert for practical applications. Although he contributed no written works on botany aside from the several pages in "Notes on the State of Virginia" dealing with plants, his enthusiasm for the subject encouraged others in their own love of it.[2] Dumas Malone says that scholars now recognize Jefferson as an American

[1] It is possible that he came by this leaning for botany from his mother, Jane Randolph, and his maternal grandfather, both of whom were ardent gardeners. His years of youth saw the rise and flowering of many prominent figures of the botanical world—Jussieu the elder, John Bartram of Philadelphia, Alexander Gardener of Charlestown, Carolus Linnaeus, who was preparing and establishing his classification and nomenclature, Adam Kuhn, perhaps the first professor of botany in our country, and André Michaux, to name a few. During Jefferson's first administration as President, Benjamin S. Barton prepared his "Elements of Botany," the first great American textbook on Botany and David Hosack set up his Eligin Botanical Garden (New York).

[2] He made certain that it would be in the curriculum which his grandson, Thomas Jefferson Randolph, would pursue in Philadelphia, in his opinion the best American city in which to obtain an education in certain of the sciences. "The garden of the Woodlands for Botany, Mr. Peale's Museum of Natural History . . . we propose there-

pioneer in numerous sciences, botany among them.

From his early days Jefferson displayed a deep interest in the sciences. Upon graduation from college he had an exceptional mastery of science for his age, and this mastery, based upon a permanently abiding interest, would have made him pre-eminent in science had he chosen to cast his life in that direction, instead of statecraft. He favored the encouragement of all the sciences, and it grieved his scientific mind that he had so little time to devote to them. Jefferson had a wider knowledge of the utility of the sciences as a whole than any other American of his time, and to list the rich harvest of improvements which resulted from his efforts on behalf of his country would require greater space than is here available. One need only think of his scientific scouting for America while on tour of southern France, northern Italy, and western Germany, where he studied the wine, oil, rice, and hay industries, or his sending home, while Ambassador to France, small supplies of Malta grass seeds and corn grains from Italy.

It is not too much to say that his scientific interests shaped his entire philosophy of life. On his return to America he sent his French friends seeds of native plants and received seeds from them. He arranged to have our consuls in every foreign port send him seed of the finest vegetables and fruits of these countries, which he gave, personally, along with cultural directions, to the market gardeners of Washington, and sometimes visited the latter, to see how the growth was progressing. Our horticulturists were thereby inspired and our markets also improved. Typical of him was his writing to James Madison for a large supply of the seeds of the Kentucky Coffee tree for his friend John Bartram, who was very anxious to obtain them. While in Paris he wrote (August 15, 1786) to Mr. Hawkins:

> "Your attention to one burthen I laid on you, encourages me to remind you of another, which is the sending me some of the seeds of the Dionaea Muscipula or Venus fly-trap, called also with you, I believe, the Sensitive Plant. This can come folded in a letter."

Also typical was his distribution of the seeds collected by the Lewis and Clark expedition to Bernard McMahon, Philadelphia nurseryman, and William Hamilton of the famous "Woodlands" garden (Philadelphia) and his corresponding with McMahon about the plants which resulted. Jefferson's role in connection with this expedition has been called "his greatest scientific opportunity". To make certain that Captain Lewis would have a sufficient knowledge of botany he wrote to his friend Benjamin Smith Barton (February 27, 1803) that when Lewis called on him in Philadelphia in two or three weeks, Jefferson would feel favored if Barton would "prepare for him (Lewis) a note . . . in the lines of botany, zoology . . . which you think most worthy of inquiry and observation." Jefferson felt it impossible to find a leader for the expedition who would combine in one person a complete knowledge of science and at the same time "firmness of constitution and character, prudence, habits adapted to the woods and familiarity with the Indian manners and character requisite for this undertaking." (Small wonder!) To Henry Inness he wrote: "Science is my passion, politics my duty," and to Benjamin Rush that only "revolutionary duties would ever have called me away from scientific studies." He was our most scientific-minded president, and might have attained the stature of a Franklin or a Leonardo had he chosen a different direction for his life. Benjamin Smith Barton, in renaming a plant "Jeffersonia" in his honor said of him: ". . . especially in botany and in zoology, the information of this gentleman is equalled by that of few persons in the United States." (Transactions of the American Philosophical Society, 3: 342, 1793)

Only a few months before he died, he wrote on April 27, 1826, to Dr. John P. Emmett, professor of natural history at the University of Virginia, which he founded, that it was time to plan for the introduction of botany into the curriculum, and gave detailed instructions for setting up a botanical garden. He thought that Dr. Emmett should "blend Rural Economics with Chemistry, Botany, and Zoology" and then give a year's course of "one dozen lectures each of Botany, Zoology, Mineralogy, and Geology, and eight dozen of Chemistry."

Even better evidence of his devotion to the science of botany is his splendid collection of books on the subject. In its day it was one of the best botanical libraries in America,[3] thus demontrating that botany was a favorite of Jefferson. While his books on agriculture were predominently in English (forty-eight) and French

fore to send him to Philadelphia to attend the schools of Botany, Natural History. . . ." (Letter to Dr. Caspar Wistar, June 21, 1807.)

[3] Students of plant-life frequently borrowed books from his library.

(twenty-four) with only five in Italian and one in Latin, his books on botany were mostly in English (sixteen) and Latin (fifteen) with only six in French and one in Italian. He used no bookplate. Instead where the printer had a "T signature" at the bottom of the page, he would complete his initials by writing "J" after it, or, if there were an "I (for J) signature," he would place the letter "T" in front of it. These books were sold along with the rest of his library, to the government of the United States in 1815[4] and became the nucleus of the Library of Congress. Of the thirty-eight books and tracts on botany, all but one were destroyed by the fire of 1851 and other causes. But the records show that he owned, and later sold to our government, the books which are listed below:[5]

1. DIOSCORIDES, PEDANIUS.

Dioscorides Libri octo Graece et Latinè, (by Jacob Goupylius) . . . Paris, 1594. 8vo.

Dioscorides, a Greek, was a surgeon in Nero's army. He originated the materia medica and was quoted for centuries as an authority on medical botany.

2. DIOSCORIDES, PEDANIUS.

Il Dioscoride del'eccellente Dottor P. A. Matthioli. Venice, 1573, (Folio)

Matthioli's Dioscorides, lectures, a newly translated sixth book of remedies for all poisons, with learned lectures, completely annotated.

3. THEOPHRASTUS.

Theophrasti Eresii de Historia Planatarum Libri decem, Graece & Latinè. Amsterdam, 1644 (Folio)

Ten books in Greek and Latin. Joannes Bodaeus à Stapel, an Amsterdam physician, elucidates and supplements the Greek texts. The Latin version has marginal interpretations and there are very complete notes and commentaries, as well as observations by Scaligerus and annotations by Constantine.

Theophrastus of Eresus, (c. 372–287 B.C.) one of the fathers of botany, was a pupil of Aristotle and inherited his library and botanic garden.

4. OEDER, GEORG CHRISTIAN.

Nomenclator Botanicus inserviens Florae Danicae. Copenhagen, 1769. (8vo.)

A botanical key to the flowers of Denmark, giving common French, English, German, Swedish, and Danish names, using the Linnean nomenclature.

George Christian Oeder (1728–1791) was a Danish physician and botanist and taught at the University of Copenhagen.

5. BRADLEY, RICHARD.

Dictionarium Botanicum: or a Botanical Dictionary for the Use of the Curious in Husbandry and Gardening. Containing the Names of the known plants in Latin, English, & c. Their description. Their Culture or Management . . . The Terms used in every Branch of Botany explain'd. A Work never before attempted. Volume I [II]. By R. Brad ley . . . London, 1728 (8vo.) Two volumes. E

Richard Bradley (1688–1732) was an English botanist. His ideas on the role of the four "elements," earth, air, fire, and water, in plant nutrition ("It is by the assistance of heat and moisture that vegetables are elaborated from the elements of earth, air, fire, and water.") were readily adopted and tenaciously held by Jefferson even though Robert Boyle had established our modern understanding of the term "element" a century earlier. From Bradley he may also have obtained the ideas that the atmosphere was the effective agent in fallowing exhausted land in order to restore its productivity and that sunlight, during summer or in warm climates, opposed this beneficial effect of air, destroying fertility of the soil. Intense sunshine, Bradley thought, produced an excess of the element fire, thus parching soil, igniting haystacks spontaneously, and causing animals to contract fever. It was not until more than one decade had elapsed after Jefferson's death that Boussingault demonstrated the power of peas to assimilate nitrogen from the air, and about five decades after that that Hellriegel and Wilfarth localized this power in the nodules of the roots of legumes.

Jefferson, however, lived during the period when vegetable physiology was beginning to be understood. Priestley, Ingen-Housz, and Senebier had made their discoveries on respiration and assimilation in green plants. He remained conservative in his obsolete modes of expression,

[4] The inventory of the Jefferson library is known as the "1815 Catalogue." The inventory of another library which he assembled later is known as the "1829 Catalogue, by Nathaniel Poor." A third library (his first) was the "1770," almost entirely destroyed by fire. All three libraries contained botany books.

[5] Throughout this study the symbols 4to, 8vo, and 12mo will be used to indicate quarto (about 8 by 11 inches), octavo (6 by 9) and duodecimo (4 by 7) respectively. The letter E. in any title means that the text is in English.

clinging to "air" as an "element" despite the discoveries of Priestley and Scheele. But we must bear in mind that Lavoisier was yet to expound the new order, and that not much was known about special plant nutritive elements, nor was Cavendish to announce the compound nature of water until 1784, one year after Jefferson completed his "Notes on the State of Virginia." Fire was still treated as an element called "caloric" until after the death of Jefferson. In his time revolutions were also taking place in mineralogical classification, botanical classification and our ideas on vegetable nutrition ("vitalistic forces" versus de Saussure's proof of origin of mineral constituents in the soil). He was, in reality, a cautious liberal in regard to science. On political revolutions Jefferson was less conservative.

6. BOERHAAVE, HERMANN

Historia Plantarum, (12 mo.) two volumes. London, 1731.

A history of the plants of the Academy Garden of Leyden; their characteristics and medicinal values.

Hermann Boerhaave (1668–1738) was the leading physician of his age and taught botany, medicine, and chemistry at Leyden. The British Museum Catalogues classify this book as "doubtful and suppositious."

7. SAINT GERMAN, J. J. DE.

Manuel des vegetaux. 1784. (8vo.)

Catalogue in Latin and French of all the plants, trees and shrubs known and arranged according to the Linnean system, by class, order, genus, and species, with the places where they grew. The plants of the vicinity of Paris are especially indicated.

8. ROUSSEAU, JEAN JACQUES — MARTYN, THOMAS.

Letters on the elements of botany. Addressed to a Lady. Translated into English with notes and twenty-four additional letters, fully explaining the system of Linnaeus, by Thomas Marytn. London: 1785. (8vo.) E

Jean Jacques Rouseau (1712–1778) addressed these letters to Madame Delessert. Thomas Martyn (1735–1825) was an English botanist. His translation went through eight editions.

9. BARTON, BENJAMIN SMITH.

Elements of Botany or Outlines of the Natural History of Vegetables. Illustrated by thirty plates. By Benjamin Smith Barton, Philadelphia: 1803. (8vo.) Two volumes in one. E

Jefferson seems to have been anxious to obtain this work, for he wrote on April 3, 1813, asking Barton "when shall we have your book on American botany . . . ." The book was the first elementary botany written by an American.

Benjamin Smith Barton (1766–1815) a Philadelphia physician and scientist, read a paper before the American Philosophical Society on May 18, 1792, naming the plant hitherto known as *Podophyllum diphyllum*, "*Jeffersonia*." Barton was professor of materia medica, natural history, and botany at the University of Pennsylvania.

10. PARKINSON, JOHN.

Theatrum Botanicum: The Theater of Plants. Or, an Herball of a large extent . . . Distributed into Sundry Classes or Tribes, for the more easie Knowledge of the many Herbes of one nature and property, with the chief notes of Dr. Lobel, Dr. Bonham and others. . . . Collected by the many yeares travaile, industry and experience in this subject, by John Parkinson Apothecary of London, and the King's Herbarist. London, 1640 (Folio) E

John Parkinson (1567–1650) was an English apothecary and herbalist.

Matthias de Lobel (1538–1616) was a French botanist.

Thomas Bonham (died 1629?) was an English physician.

11. TOURNEFORT, JOSEPH PITTON DE.

Institutions rei herbariae. Lyons, 1719. (4to.) Two Volumes.

Characteristics of plants. Augmented by Anthony de Jussieu.

Joseph Pitton de Tournefort (1656–1708) was a French botanist.

Antoine de Jussieu (1686–1758) was a French botanist and physician. His work on this book won him admission to the French Academy.

12. LINNAEUS, CAROLUS.

Philosophia Botanica. Vienna, 1763 (8vo.)

Explanation of fundamentals of botany with definitions, examples, and various observations.

13. LINNAEUS, CAROLUS.

. . . *Critica botanica*. Leyden, 1737 (8vo.) A botanical critique of plant classification and a discussion by Johannes Browallius on natural history.

Johannes Browallius (1707–1755) was a Swedish naturalist, botanist, and theologian.

14. LINNAEUS, CAROLUS.

Genera plantarum. 1764. (8vo.) A book on plant classification.

15. LINNAEUS CAROLUS.

. . . *Species Plantarum*, 1762–3. (8vo.) Two volumes.

This is the work in which Linnaeus (1753 edition) set forth in full the specific names of plants. The book seems to have been cherished by Jefferson, for he not only purchased one set, but also tried to import another, and also selected a third set from the library of the Reverend Samuel Henley.

Jefferson gave a minutely detailed classification of the different types of vegetation found in Virginia in his "Notes on the State of Virginia," dividing all vegetation into four classes: medicinal, esculent, ornamental, and useful for fabrication. Common and scientific (Linnaean) names were given, thus showing that at heart he was a scientific, professional botanist.

To Dr. Manners he wrote on February 22, 1814: "Linnaeus' method was received, understood and conventionally settled among the learned and was even getting into common use. To disturb it then was unfortunate. The new system attempted in botany by Jussieu . . . is subject to the same regret . . . . I adhere to the Linnaean system . . ."

16. LINNAEUS, CAROLUS.

Flora Lapponica. Amsterdam 1737 (8vo.)

This is a report on Linnaeus' trip of exploration of Lapland for the Swedish Academy of Sciences, which underwrote the costs of the trip. Synonyms, habitats, descriptions, medicinal virtues and economic importance are given.

17. LINNAEUS, CAROLUS.

A System of Vegetables, according to their classes, orders, genera, species, with their characters and differences. Translated from the Thirteenth edition (as published by Dr. Murray) of the Systema Vegetabilium of the late Professor Linneus; and from the Supplementum Plantarum of the present Professor Linneus. London, 1782. (8vo.) E

The thirteenth edition of "Systema Vegetabilium" was translated by Erasmus Darwin and others. Acknowledgments in the Preface include one to "that great Master of the english tongue, Dr. Samuel Johnson, for his advice in the formation of the botanic language."

18. LINNAEUS, CAROLUS.

Fundamenta Botanica. 1786–7 (8vo.) Three volumes.

Fundamentals of botany in the form of aphorisms.

19. LINNAEUS, CAROLUS—SMITH, SIR JAMES EDWARD.

A dissertation on the sexes of plants. Translated from the Latin of Linnaeus. By James Edward Smith . . . London, 1785. (8vo.) Two volumes, together. E

Sir James E. Smith (1759–1828) English botanist, was the purchaser of the library, manuscripts, and natural history collections of Linnaeus, father and son.

20. DARWIN, ERASMUS.

The Botanic Garden. A Poem, in two Parts. Part I Containing the Economy of Vegetation. Part II, The Loves of the Plants. With philosophical notes. New York, 1798. (8vo.) E

Erasmus Darwin (1731–1802) English physician, had a botanical garden in Lichfield.

21. PERSOON, CHRISTIAN HENRIK.

Synopsis Plantarum. Paris, 1805–7. (12mo.) A systematic enumeration of the known species of plants. Two volumes.

This book was sent to Jefferson on behalf of the author, by David Warden, American Consul at Paris, December 21, 1807. In October 1810 he lent it to Benjamin Smith Barton, and after the sale of his library to Congress in 1815, he wrote Barton for its return, because "it is now become their [Congress's] property and of course my duty to collect and put in place whatever stood in the Catalogue by which they purchased. . . . I am in hopes you will have been able to make it answer the purposes for which you asked it's use."

To Dr. John Manners he wrote (February 22, 1814): "in Botany Wildenow and Persoon have incorporated into Linnaeus the new discovered plants . . . ."

Christian Hendrik Persoon (1755–1836), Dutch naturalist, was born in Cape Town, died in Paris.

22. *Crownenshield's Hortus Siccus*. (8vo.) MS.

Jefferson wrote (December 29, 1808);

"I received safely by Genl. Dearborne the specimens you were so kind as to send me, of a

hortus siccus by Mr. Crowenshield, and of drawings with the pen by Miss Crowenshield. the relations of my late friend [Jacob Crowninshield 1770–1808], and the excessive pressure of business, during a session of Congress must be my apology for this late acknolegement. I have certainly never seen anything, in either way, equally perfect, and I esteem them as models which will not, I believe be exceeded. I pray you to accept my acknolegements for this mark of attention from yourself, and to be so good as to present to the young artists the assurances of my thankfulness for these acceptable proofs of their uncommon talent. if my testimony of their eminence can be any gratification to them, it is offered with sincerity, and justly due them . . . ."

(A "hortus siccus" [literally "dry garden"] is a herbarium or a collection of dried and preserved botanical specimens.)

23. GRONOVIUS, JOHANNES FREDERICUS — CLAYTON, JOHN.

Flora Virginica. Leyden, 1762 (4to.)

John Clayton collected and studied the plants of Virginia, and presented the collection to Gronovius, who studied them further, then described and classified them. The third edition of this work was revised to accord with the system of Linnaeus.

In his "Notes on the State of Virginia," which was the most important scientific work published in America up to its time and gave Jefferson a great reputation as a scholar and man of science, he gave a list of Virginia trees, plants, fruits, etc., and the first description of the pecan. (He published no other botanical works.) After this list he wrote:

> "There is an infinitude of other plants and flowers, for an enumeration and scientific description of which I must refer to the Flora Virginica of our great botanist, Dr. Clayton, published by Gronovius at Leyden, in 1762. This accurate observer was a native and resident of this state, passed a long life in exploring and describing it's plants, and is supposed to have enlarged the botanical catalogue as much as almost any man who has lived."

This was the first flora of Virginia ever published and Jefferson was dependent upon it for much of his botanical knowledge, referring the reader of his "Notes" to Clayton for further information.

Johannes Gronovius (1690–1760) was a Dutch naturalist.

John Clayton (1693–1773), English botanist, came to Virginia in 1705 and Jefferson's statement that he was a native is an error.

24. SHECUT, JOHN LINNAEUS

Flora Carolinaeensis or, a Historical, Medical, and Economical Display of the Vegetable Kingdom; according to the Linnaean, or sexual System of Botany . . . In two volumes. (8vo.) Vol. I. Charleston, 1806. E

A presentation copy by the author, who wrote that he felt that Jefferson was "not only an Advocate for, but a Promoter and encourager of American Arts and Sciences . . ." and hoped that "it may afford you a few moments amusement, in hours not immediately occupied with subjects of greater importance . . . ."

On March 22, 1807 Jefferson wrote:

> "Th: Jefferson returns his thanks to Mr. Shecut for the 1st volume of his Flora Carolinaeensis which he has been so kind as to send him. as a Botanical institute & dictionary as being in English and containing much new matter, it promises to be among the most useful manuals in that science . . . ."

On June 29, 1813 he wrote:

> ". . . I have been in the constant hope of seeing the 2nd vol. of your excellent botanical work. it's alphabetical form & popular style, it's attention to the properties & uses of plants, as well as to their descriptions, are well calculated to encourage and instruct our citizens in botanical enquiries. . . ."

John Linnaeus Edward Whitridge Shecut (1770–1836) was a South Carolina physician, botanist and author. This book was the most extensive botany of his state at the time.

25. WALTER, THOMAS.

Flora Caroliniana. London, 1788. (8vo.)

Essential nature of the flora of Carolina, with numerous additions to previous descriptions and containing more than one thousand sketches of plant life.

Jefferson wrote James Madison from Paris, January 12, 1789, "I have just received the Flora Caroliniana of Walter; a very learned and good work."

Thomas Walter (1740–1789) was born in England and emigrated to South Carolina, where he was a prominent figure in early American botany.

26. MARSHALL, HUMPHRY.

Arbustrum Americanum: the American grove, or, An Alphabetical catalogue of forest trees and

shrubs, natives of the American United States, arranged according to the Linnaean system . . . . Compiled from actual knowledge and observation and the assistance of botanical authors. Philadelphia, 1785. (8vo.) E

Jefferson wrote from Paris on August 14, 1786, to Francis Hopkinson:

"will you be so good as to send me a copy of a Botanical book published by some person in the country not far from Philadelphia, whose name I have not heard . . . ."

Humphry Marshall, (1722–1801), was a native Pennsylvanian, botanist, cousin of John Bartram, and member of the American Philosophical Society, to whose president, Benjamin Franklin, and other members it is dedicated.

27. TRACTS IN BOTANY

I. *Marshall's American Grove* E

II. Gouan, Antoine. *Explication du Système botanique du Chevalier von Linné* Montpellier, 1787. (Explanation of Linnaeus's botanical system):

III. Kennedy and Lee's *Catalogue of Plants and Seeds.* London, 1784. E

(All three bound in one 8vo. volume.)

Antoine Gouan (1733–1821), French botanist, corresponded with Jefferson and sent seeds and plants from Montpellier.

28. MICHAUX, ANDRÉ.

Flora Boreali-Americana. Paris and Strasburg, 1803 (8vo.) A description of the flora of North America, collected and studied by André Michaux. Two Volumes.

Jefferson found that the cost of this book was very high. On January 23, 1805 he wrote a dealer "what is the price of the 8vo. edition of Michaux' Flora boreali-Americana? the price of the 4to. ed'n. deterred me from taking that . . . ." In December 1804 the quarto edition was offered at $24.00. In January 1805 he paid $8.64 for the 8vo. edition.

On July 6, 1806, Michaux's son, François André, sent Jefferson a copy of his "Voyage à l'ouest des Monts-Alleghanys," whereupon Jefferson wrote:

"Th: Jefferson . . . possesses the Flora Americana of his father & has seen his work on the American oaks, both of which are valuable editions to our Botanical libraries . . . ."

André Michaux, (1746–1802), French botanist and naturalist, travelled from 1785 to 1797 to the Missouri and West, financed by American Philosophical Society funds raised through Jefferson's efforts.

29. DUMONT DE COURSET, GEORGE LOUIS MARIE BARON

Le botaniste cultivateur. Paris, 1802–4. Description, cultivation and use of most foreign, naturalized and indigenous plants, cultivated in France and England, arranged according to the method of Jussieu. (8vo.) Four Volumes.

Jefferson was glad to obtain this set and tried to obtain the fifth volume, which appeared in 1805.

30. MICHAUX, FRANÇOIS ANDRÉ.

Histoire des arbres forestiers de l'Amerique septentrionale. Paris, 1810–12. History of forest trees of North America considered chiefly with respect to their use in the arts and introduction into commerce. Large 8vo. Two volumes in one, with large colored plates.

On receiving Michaux's account of the pines and firs in volume 1, Jefferson wrote on April 15, 1811:

"I have duly received your favor of Aug. 10 and, with it, your beautiful account of the pines & firs of our country, for which be pleased to accept my thanks. I sincerely wish that the work may be prosecuted, & that the citizens of the United States may not be wanting in due encouragement to it. nothing should be spared which I could do to befriend it . . . ."

François André Michaux (1770–1855) was a French physician, naturalist, and author of several books on the Natural History of America.

31. MICHAUX, ANDRÉ

Histoires des Chênes de l'Amerique. Paris, year IX(1801) (Folio). History of the American Oaks or descriptions and figures of all the species and varieties of the oaks of North America in relation to Botany, to their cultivation and to their use.

The price originally asked of Jefferson (November 5, 1804) was $10.00. He found this price too high, writing that he was returning it to the dealer "because it was too large & unhandy rather an object of the luxe typographique than of use", and asking for a smaller edition. "if not, will you indulge me with another examination of the large one & say what the price is."

32. ROSCOE, WILLIAM

Address at the opening of the Botanic Garden of Liverpool, previous to opening the garden, May 3, 1802. Liverpool, (1802) (8vo.) E

William Roscoe (1753–1831), English historian, was a botany enthusiast, who contributed to the Transactions of the Linnean Society.

33. ROSCOE, WILLIAM

A catalogue of Plants in the Botanic Garden, at Liverpool. Liverpool, 1808. (8vo.) E

This was a presentation copy from the compiler of the catalogue.

34. DUHAMEL DU MONCEAU, HENRI LOUIS AND LA GALISSONNIÈRE, ROLLAND MICHEL BURIN, MARQUIS DE

Avis pour transport par mer des arbres. 1752 (Place not stated). Advice on transportation by sea, of trees, perennial plants, seeds, animals, and different other curiosities of natural history.

D. du Monceau (1700–1782) was a French botanist and engineer. The Marquis de La Galissonnière (1693–1756) was a French sailor and naturalist.

35. WATERHOUSE, BENJAMIN

The Botanist. Being the Botanical Part of a Course of Lectures on Natural History, delivered in the University at Cambridge. Together with a Discourse on the Principle of Vitality. Boston, 1811. (8vo.) E

This was a presentation copy from the author, who wrote Jefferson that natural history had never been taught in his "quarter of the Union untill I commenced the subject about 25 years ago;" that because it was a new study he had to teach it in popular form; that "the Essex Junto had got such an entire possession of our University, & had made it a fort, or stronghold, whence to annoy Republicanism, that I saw I must quit them; and this expedited the publication of the Botanist."

Jefferson wrote:

"I thank you for the book you have been so kind as to send me. it puts a dry subject into a pleasant dress; and explaining the principles of vegetation as well as of Botany, it will be a better preparation to a student than the elementary books generally are. that it's sale should have been succeeded only South of Connecticut proves two things; one which I have long observed, that the scale of science cultivated in the east is more limited than that to the South. the clergy, who are afraid of science every where, controuling it there. the second, that the fell hatred of party spirit thinks no persecution too mean . . . ."

"The Botanist" is a series of essays which appeared in the "Monthly Anthology" of Boston (1804–1808).

Benjamin Waterhouse (1754–1846), was a Rhode Island physician and the pioneer vaccinator of America, whose experiments and successful establishment of the practice of vaccination had the help of Jefferson's strong support.

36. MUHLENBERG, HENRY

Catalogus Plantarum Americae Septentrionalis. Lancaster, 1813. (8vo.) A Catalogue of the hitherto known native and naturalized plants of North America, arranged according to the sexual system of Linnaeus. E

This is the only remaining botany book (of all those sold by Jefferson) which escaped loss by fire or other kinds of destruction.

Page 40 bears a description of the plant "Jeffersonia" renamed by Benjamin Smith Barton (see item #9 above).

This was a presentation copy from the author, to whom Jefferson wrote on March 16, 1814:

"I thank you for your catalogue of North American plants. it is indeed very copious, and at the same time compendious in its form. I hardly know what you have left for your 'Descriptio uberior'. the discoveries of Govr. Lewis may perhaps furnish matter of value, if ever they can be brought forward. the mere journal of the voyage may be soon expected; but in what forwardness are the volume of the botany, natural history, geography, and meteorology of the journey I am uninformed . . . . with my wishes for the continuance and success of your useful labors I embrace with pleasure this first occasion of assuring you that I have had long and much gratification in observing the distinguished part you have borne in making known to the literary world the treasures of our own country and I tender to you the sentiments of my high respect and esteem . . . ."

Henry Muhlenberg, (1753–1815) was a Lutheran clergyman and botanist of Pennsylvania.

The following botany books were also owned by Jefferson, who classified them under natural philosophy.

1. VON HUMBOLDT, FRIEDRICH HEINRICH ALEXANDER, BARON.

"Tableaux de la Nature, ou Consideration sur les déserts, sur la Physionomie des Végétaux, etc." Paris, 1808. A study of desert vegetation.

A presentation copy by the author. Jefferson wrote:

> ". . . the extreme satisfaction I have received from Baron Humboldt's communications. the treasures of information which he possesses are inestimable, and fill us with impatience for their appearance in print."

2. INGENHOUZ, JAN

"Electricité sur les Vegetaux"

The effect of electricity upon plants (Ingenhouz thought at first that electricity would stimulate the growth of plants, but later retracted his theory).

Jefferson misunderstood Ingenhouz, holding that Ingenhouz believed that plants obtain their nutriment from light. Ingenhouz did, in truth, understand light as the activating influence we now know it to be.

3. *"Elements of Botany"* M.S. (Author's name not stated.)

4. RUSH, BENJAMIN

"An Account of the Sugar Maple-Tree" etc.

A footnote on page 14 reads "Mr. Jefferson uses no other sugar in his family, than that which is obtained from the sugar maple tree. He has lately planted an orchard of sugar maple trees on his farm in Virginia."

Jefferson's books which are not entirely on botany, and which he placed in other divisions of his library (viz. "Catesby's Natural History of Carolina", in his zoology section), are not mentioned in this study.

The Jefferson library of 1829, referred to in footnote 4, had books on botany by the following authors:

1. PERSOON
2. MICHAUX (*"North American Sylva"* 3 volumes in 2)
3. CLAYTON (*"Flora Virginica"*)
4. RAFFINESQUE (*"Flora Louisina"*)
5. ——— (*"Catalogue of the Plants of New York"*)
6. HUMBOLT (*"Distributio Geographica Plantorum"*)

Books seem to have held a chief delight for Jefferson:

> "I have withdrawn from all political intermeddlings, to indulge the evening of my life with what have been the passions of every portion of it, books, science, my farms, my family and friends."
> (Letter to James Maury, April 25, 1812)

His enthusiasm and vision for botany were no less keen. Writing, in 1789, to President Willard, of Harvard, he said:

> "What a field have we at our doors to signalize ourselves in! The Botany of America is far from being exhausted, its mineralogy is untouched, and its Natural History or Zoology totally mistaken and misrepresented. . . ."

How appropriate that he should have been referred to by the naturalist De Kay as "the Great Patriarch of American Natural History."

ACKNOWLEDGMENTS

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The Botanical Library of the University of Pennsylvania

The Library of the American Philosophical Society

LITERATURE CITED

BROWNE, CHARLES A. 1944. Thomas Jefferson and the scientific trends of his time. Chron. Bot. **8** (3): 363–423.

LIPSCOMB, ANDREW G. (ed.). 1903. The writings of Thomas Jefferson. Washington.

OLIVER, JOHN W. 1943. Thomas Jefferson, scientist. Sci. Month. **56**: 460–467.

TRUE, RODNEY. 1916. Thomas Jefferson in relation to botany. Sci. Month. **3**: 345–360.

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DR. JOHN N. COUCH, *Editor*
Department of Botany
University of North Carolina
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(5) BRAUER, A., AND N. MACON. Amer. Jour. Math. **71**: 349–361. 1949.
BAILEY, JOSEPH R., AND DAVID G. FREY. 1951. Darters of the genus *Hololepis* form some natural lakes of North Carolina. Jour. Elisha Mitchell Sci. Soc. **67**: 191–203.
FERNALD, M. L. 1950. Gray's Manual of Botany, 8th ed. American Book Company.

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Contents—*continued from front cover*

A Preliminary Experiment in Swine to Determine the Effectiveness of Cadmium Oxide against *Trichinella spiralis*
John E. Larsh, Jr. and Hilton T. Goulson 19

Insecticides Combined with Herbicidal Oil for the Control of the Carrot Rust Fly, *Psila rosae* (F.) (Diptera: Psilidae)
H. Eldon Scott 22

Distribution of Some Lignicolous Ascomycetes and Fungi Imperfecti in an Estuary ..... *Harvey S. Gold* 25

Additions to the Fresh-Water Algae in North Carolina III
G. J. Schumacher and L. A. Whitford 29

A Relict Plant Community in South Carolina ..... *Albert E. Radford* 33

Species New to the Flora of South Carolina
Albert E. Radford and Harry E. Ahles 35

The Botanical Library of Thomas Jefferson
Marion B. Savin and Harold J. Abrahams 44